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U. S. A.:	80 cents
British Isles:	5 s
Switzerland:	Fr. 2.80
Netherlands:	Fl. 2.80
Denmark:	d. Kr. 5.—
Germany:	DM 3.—
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The Aircraft Carrier... Giant or Pigmy?

VOLUME VIII 3 1953

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Volume VIII — No 3 — 1953

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Circulation : E. S. Annaheim

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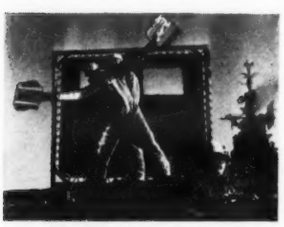

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Appears Monthly in Four Editions : English, French, Spanish and German.

Advertising Department, Publishing and Editorial Offices, Subscription Department : Interavia S. A., 6, Corraterie, Geneva. Telephone : 5 42 34 (five lines). Cables and Telegrams : Interavia-Geneva.

Annual Subscriptions : Switzerland, Sw. frs. 28.00; U. S. A. and Canada, U. S. $7.00; Great Britain, £2 6s Od; France, Fr. frs. 2,400; Belgium, Belg. frs. 360.00; Holland, Fl. 28.00 Germany, DM 28.00; Sweden, Kr. 35.00; Norway, Kr. 50.00; Spain, Ptas 275.00; Austria, ö. S. 180; Brazil, 230 Cr$; Uruguay, 23 pesos. All other countries : Sw. frs. 28.00.

Agents and Distributing Offices :

INTERAVIA AUSTRIA : Morawa & Co., Wollzeile 11, Vienna I.
INTERAVIA BELGIUM : Office de Publicité, 16, Rue Marcq, Brussels.
INTERAVIA BRAZIL : R. F. Besnard, 91 av. Almirante Barroso, S. 417-419, Rio de Janeiro. 131, rua Marconi 5° And., Sao Paulo.
INTERAVIA CANADA : Wm. Dawson Subscription Service Ltd., 587 Mount Pleasant Road, Toronto 12, Ontario.
INTERAVIA DENMARK : Dansk Centralagentur, Stormgade 20, Copenhagen.
INTERAVIA FINLAND : Akateeminen Kirjakauppa, Keskuskatu 2, Helsinki - Rautatiekirjakauppa Oy, Köydenpunojank 2, Helsinki.
INTERAVIA FRANCE : 144, Champs-Elysées, Paris VIIIe.
INTERAVIA GERMANY : Interavia GmbH., Tieckstr. 5, Cologne-Ehrenfeld, Subscriptions and single copies : Ausland-Zeitungshandel W.E. Saarbach, Gereonstrasse 25-29, Cologne 1. Postal Cheque Account Cologne 25823.
INTERAVIA GREAT BRITAIN : Interavia (United Kingdom) Ltd., 2-5, Old Bond Street, London, W. 1.
INTERAVIA HOLLAND : Rotterdamsche Couranten-Import en Kioskenonderneming v/h van Ditmar, Postbus 262, Rotterdam.
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INTERAVIA URUGUAY : R. F. Besnard, Edificio Artigas, Rincôn 487, Montevideo.
INTERAVIA U.S.A. : 385 Fifth Avenue, Room 1408, New York 16, N.Y. Subscriptions also from the International News Co., 131 Varick Street, New York, N.Y.

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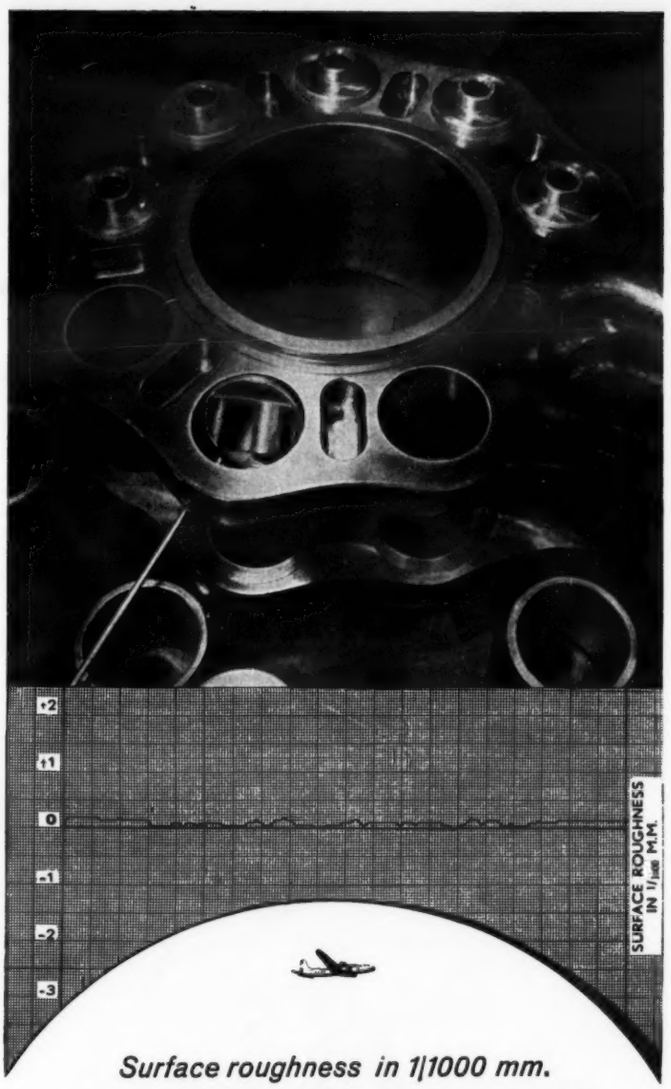
Printed in Switzerland

Imprimeries Populaires, Genera — Héliographia S. A., Lausanne
Imprimerie de "La Tribune de Genève", Geneva



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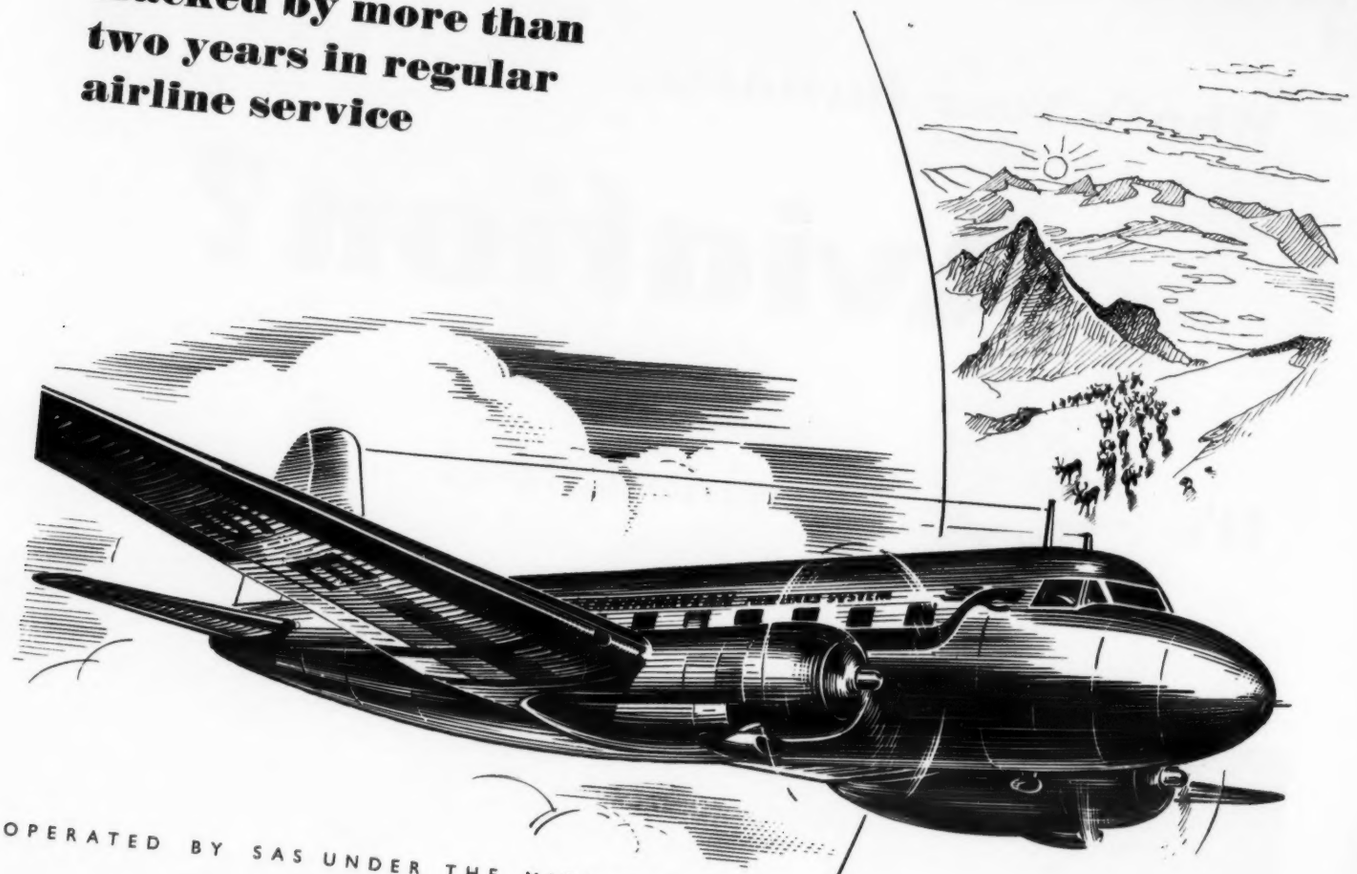

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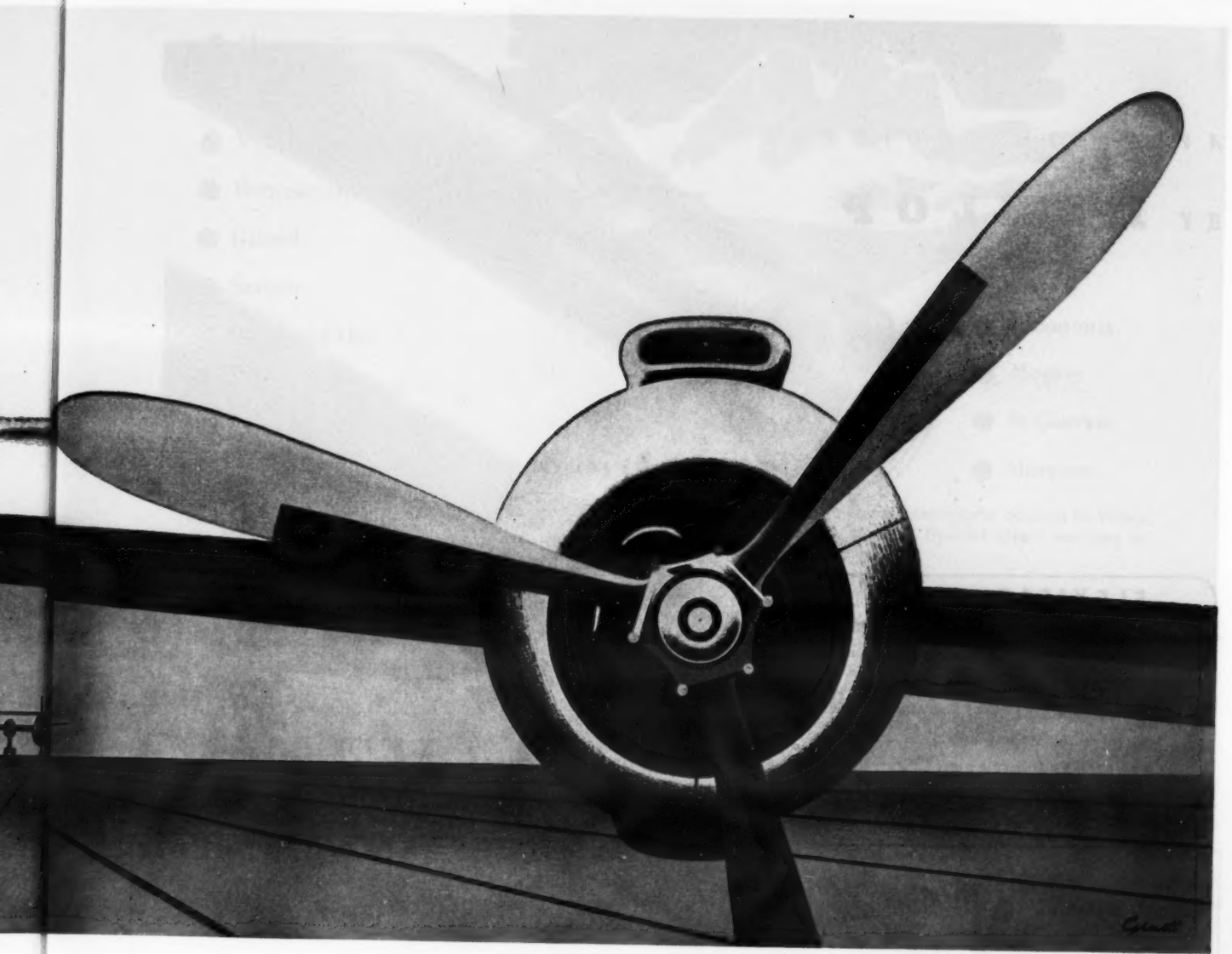

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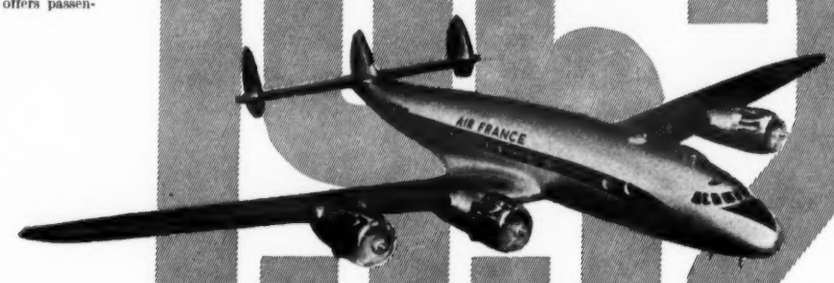

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NOVEMBER :	Mulhouse-Marseilles-Algiers service. Paris-Tokyo service by Constellation in a flying time of 37 hrs. 30 mins.
DECEMBER :	Installation of sky lounge chairs on one of the Paris-Casablanca services. New luxury service to Dakar.
JANUARY 1953 :	Opening of Paris-Caracas-Bogota service.

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The Aircraft Carrier—Giant or Pigmy?

Since World War II, when aircraft carriers protected Allied convoys and helped to win the battles in the Pacific, even the layman has known what an aircraft carrier is. At least he thinks he knows. The Korean War, where it has been able to cruise undisturbed off the coasts of Asia, has brought it back into the news again. The admirals proclaim it as the *non plus ultra,* but air force leaders wave it aside with an ironical smile.

The policies of the United States, the strongest sea power in the world, in this domain during recent years have shown the most amazing contradictions. In April 1949 the building of the giant carrier *United States* (60,000 tons) was cancelled overnight. In mid-1952 the programme was revived ; two ships of the Forrestal class (59,900 tons) have already been laid down and another eight are to follow.

The term aircraft carrier has often been used politically. Before the last war Hitler regarded Czechoslovakia as an aircraft carrier anchored in the heart of Europe. Today the British Isles are regarded in much the same light by the Russians. Mussolini decided against aircraft carriers because he believed—mistakenly—that he could dominate the "mare nostrum" with his bombers, and was anxious to avoid unnecessary expenditure. And Göring? He had no more than played with the idea of carriers, as his strategists had warned him that the Royal Navy would undoubtedly be masters in any naval warfare in the North Sea.

However, the real sea powers, the United States, Great Britain, France and Japan, have never entirely lost their affection for the aircraft carrier. To demonstrate the potentialities of the carrier even more clearly, the United Sates and Britain organized a massive carrier exercise in the North Sea during the summer of 1952, under the symbolic name of "Exercise Mainbrace." This operation proved to be a failure.

But did this provide a final answer to the aircraft carrier question ?

A British supporter of the carrier writes in one of the articles below : "... It is extraordinary how much hot air is generated by the aircraft carrier, whilst the degree of sloppy thinking on the subject is beyond computation ..."

An officer of the French Air Staff remarks how simple things would be if the aircraft carrier were really a trump card, but laments that stern reality has shown hopes of using it as such to be but a rosy dream.

This March issue is devoted to a closer examination of the *aircraft carrier question.* Without ourselves in any way taking sides, we publish articles by both partisans and opponents of the aircraft carrier. Lists and tables are included to show just what is meant by carrier forces and carrier-based air units, and how much they cost.

Perhaps these articles may help to clarify ideas on the subject and show the taxpayer whether or not his money is being well spent.

The Aircraft Carrier Today and Tomorrow

BY VICE-ADMIRAL PIERRE BARJOT

FORMER COMMANDER OF THE FRENCH NAVY'S CARRIER-BORNE AIR UNITS AND AIRCRAFT CARRIER GROUP

Vice-Admiral Barjot is a submarine and naval aviation specialist.

During the war (1944-1945) he was Deputy Chief of Staff for National Defence, and later held the following posts :

Flag Officer Commanding Naval Units, Morocco and Tunisia.

Commander of Carrier-borne air units and Aircraft Carrier Group.

French Commander-in-Chief of the Indian Ocean strategic zone, with authority over land, sea and air forces.

Admiral Barjot is a firm supporter of aircraft carriers, and has written several papers on the subject for the Association Technique Maritime et Aéronautique *in Paris. He is one of the advocates of the use of light aircraft carriers in anti-submarine warfare and of the tactics of the* Hunter-Killer group, *which he has himself had the opportunity of applying during inter-allied exercises.*

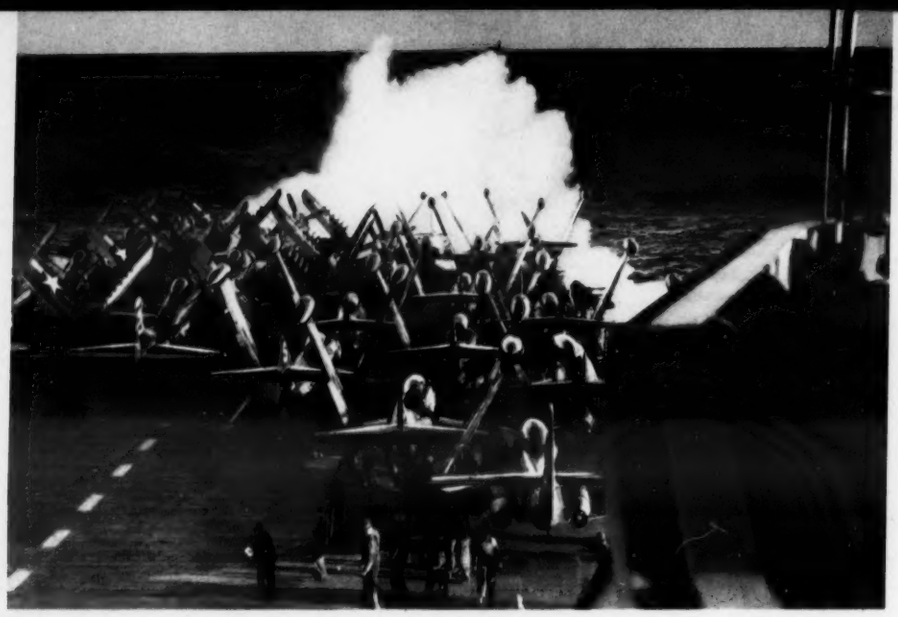
Admiral Barjot has had operational command of French naval air units during four NATO exercises, Verity (1949), Symphony (1950), Beehive I (1951) and Beehive II (1952).

He was recently invited to the United States to read a paper to the Naval War College, Newport, on the naval defence of the "European Peninsula."

Introduction

The value of the aircraft carrier in air warfare is periodically questioned. Sometimes it is the range of land-based aircraft and the inferior performance of carrier-based types, at others the vulnerability of the operating platform that are used as arguments by those who dispute its utility. These criticisms must be examined objectively. But the essential point, which has never been sufficiently stressed, is the ability of the aircraft carrier to form air concentrations.

Although it is now thirty-five years old, the aircraft carrier did not reveal its capabilities until ten years ago, in 1943, when it showed it could attack land-based air units instead of merely seeking to escape them. Its motto, like that of Marshal de Lattre de Tassigny, was "do not submit." But it was not long before it came into conflict with a long-range heavy bomber, the B-36. Rival loyalties came into play at the Pentagon in 1948, and again in the



Since 1950 the Korean war has given the aircraft carrier a new chance to prove its worth. The U.S.S. *Essex* with Grumman F9F "Panther" and McDonnell F2H "Banshee" jet fighters (extreme right) and Douglas AD "Skyraider" piston-engined fighter bombers (left), with heavy seas breaking over the decks.

Vinson Committee discussions in 1949. This was the time when the aircraft carrier appeared to be having great difficulty in adapting itself to jet powered aircraft. At first the B-36 won against the admirals, but it did not survive its Pyrrhic victory. Then, from 1950 on, the Korean War provided American aircraft carriers with a vast field of experience in the use of subsonic jet aircraft, experience which served as preparation for the use of transonic and supersonic aircraft. By 1952, the case of the aircraft carrier had been won, as is proved by the *Forrestal* programme.

As aircraft performance and hence specific fuel consumption increase (an extreme case is provided by the 1,500 m.p.h. Douglas "Skyrocket" and its ten-minute endurance), manned or unmanned aircraft used at sea will have to rely to an even greater extent on an operational and electronic platform. In consequence, the value of the aircraft carrier will increase.

The basic principle : air concentration

The *raison d'être* of modern aircraft carriers is their ability to provide rapidly a concentration of air power, to place it within range of the chosen target at the required moment and to enable it to operate in less time than would be required to organize a similar concentration from land bases. This air concentration can also be moved about at sea, thus enabling its point of application to be changed.

There are two other principles which characterize modern carrier-borne aviation, namely:

— the principle of equality of performance with land-based air forces, which enables it to operate against coastal targets ;

— the principle of precision of impact which makes of it a highly efficient weapon against both land targets and naval targets.

A close air concentration can be obtained by aircraft carriers thanks to the high take-off and landing rate. It means that aircraft must be parked very close together on the deck both before take-off and after landing. This is possible thanks to the aircraft's folding wings, which reduce the width of the space required by 50%.

The direct take-off method, head into the wind, consists of using an assisted take-off of 40 to 50 knots (carrier's speed 30 knots, plus a moderate wind of 10 to 20 knots). This method cannot be used for jet aircraft, and the catapulting method has thus been generally adopted. Jet aircraft are more and more heavily loaded on take-off. Fuel forms 25 to 30% of the total loaded weight on take-off whereas the percentage in propeller-driven aircraft is no more than 15 to 20%.

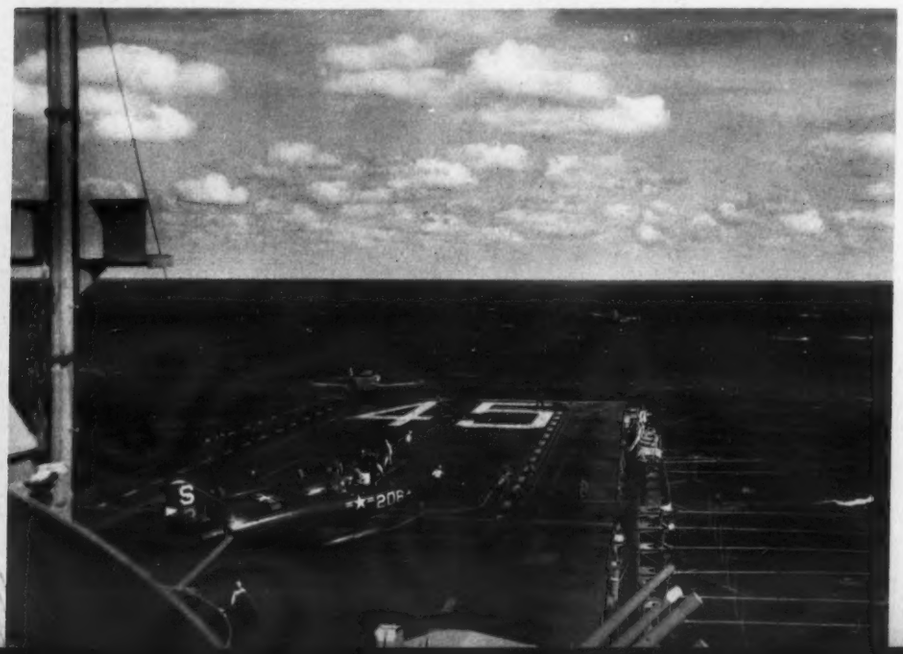
One catapult can launch an aircraft every 30 seconds. With the two catapults fitted in present-day aircraft carriers, a take-off rate of one aircraft every 15 seconds can be obtained. This means that an air group of 24 aircraft can get into the air in six minutes from a light aircraft carrier of the *Lafayette* type. In the *Forrestal,* which will have four catapults, it is hoped to get a take-off rate of 32 aircraft in four minutes.

The speed of the carrier, which provides an aid to take-off, also reduces relative landing speed. The arresting lines do the rest.

In the present stage of technical development the deck landing rate is one aircraft per 30 seconds, and it would seem to be difficult to improve on this with only one landing runway. This rate, already very high, is obtained by the combination of arrester hooks, arresting lines and crash barriers which protect the parking area. The latter is an extension of the landing area.

With transonic aircraft presenting themselves for landing at high approach speeds (120 knots), the landing axis will have to be shifted in relation to the parking area ; such a

With two catapults, such as are fitted in modern aircraft carriers (here the U.S.S. *Valley Forge*), the take-off rate can be reduced to one aircraft every 15 seconds. A Grumman F9F "Panther" taking off.



"canted" or "angled" deck has recently been fitted to the U.S. carrier *Antietam*. It prevents the landing line from extending into the area where aircraft which have just landed are parked. It would also be possible to eliminate the crash barriers, reduce the number of arresting cables and increase their elasticity for a similar deceleration.

In the *Forrestal*[1] there are to be two landing runways, one starboard and the other port. The landing rate can thus be doubled. The engineers are making every possible effort to enable aircraft carriers to achieve the principle of air concentration.

Importance of electronic support

Without radar, the aircraft carrier could not have become what it is today. By means of its electronic and D/F system and its R/T communications with its aircraft in flight, the carrier constantly supports its own aircraft and warns them of the movements of enemy aircraft. Electronic cover is greatly increased by using radar aircraft known as early warning aircraft carrying panoramic radar equipment which is repeated on board the aircraft carrier.

The electronic panorama in the aircraft carrier is considerably larger. The installation of control posts on warships, including destroyers, gives carrier-borne air units a more highly developed operational ground organization than is possible on land.

The newer aircraft carriers can be used for landings at night or in bad weather, thanks to a system of Carrier Control Approach similar to the Ground Control Approach in use at the better equipped airfields. The modern aircraft carrier can thus operate 24 hours a day. It may be added that automatic landing is also being tried out (in the *Oriskany*), to reduce the pilot's work.

Mobility and concealment

The aircraft carrier's mobility presents two tactical advantages :

— take-off platforms can be grouped together, so that the aircraft themselves do not have to "rendez-vous" in the air after taking off from a number of airfields ;

— the point of departure of the air concentration can be moved.

In one night fast aircraft carriers can travel from 500 to 600 miles and arrive the next morning in front of a new target.

Although he treats this distance as relatively small, Major Alexander de Seversky,[2] the aircraft carrier's chief opponent, is obliged to concede it the advantages of mobility and concealment. This nearly always gives the aircraft carrier the initiative in operations against land-based air forces.[3]

Twenty Boeing B-29 "Superfortress" medium bombers scattering eight hundred 500 lb. bombs over the target area (above) have the same chance of success against a *pin-point target* 430 sq.ft. in area as a single carrier-borne fighter (here a Grumman F6F "Hellcat") with two "Tiny Tim" rockets.

Fighters hold a preponderant place on board aircraft carriers not only for defence (interception) but also for attack (escort and assault). By using early warning aircraft, it is possible to reduce the number of fighters kept in the air as an "umbrella" to protect the naval force and aircraft carriers, and thus increase the number available for escorting bombers.

Attacks on land airfields and destruction of the enemy's air units on the ground are the first task of aircraft carriers. These are in general the first targets for strikes.

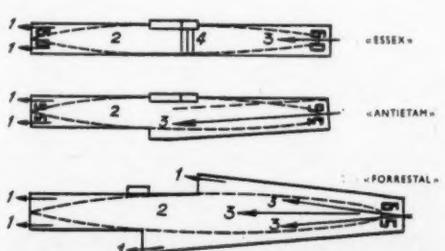
The aircraft carrier's efficiency increases in the offensive

It may perhaps seem outdated in 1953 to talk of the Pacific, but this theatre of operations still remains the aircraft carrier's greatest field of experience and furnishes interesting criteria which are still valid for the future :

— of the 12,268 Japanese aircraft destroyed by American aircraft carriers, 93 % or 11,368 were land-based aircraft ;

— 5,769 of these aircraft, or *47 % of the total,* were destroyed *on the ground* in strikes against airfields.

One criterion of the efficiency of a given method of air warfare is the percentage of aircraft destroyed on enemy territory. A method which gives 47 % is certainly superior to one which gives 29 %, the percentage obtained by the U.S. Air Force, with 2,981 aircraft destroyed on the ground out of the 10,343 Japanese aircraft to its credit in the Pacific War.



The development of landing decks from 1943 to 1953:

U.S.S. Essex :	2 Catapults
	1 straight landing deck
U.S.S. Antietam :	2 Catapults
	1 canted deck
U.S.S. Forrestal :	4 Catapults
	2 canted decks
	1 straight deck (for heavy bombers)

1. Catapults
2. Parking areas
3. Landing decks
4. Crash barriers

[1] The 59,900-ton *Forrestal* is the prototype of a "strategic" aircraft carrier, ten of which are to be built for the U.S. Navy. The prototype was laid down at Newport News on July 14th, 1952, and is to be launched in 1954. The second, which has been named *Saratoga*, was laid down in December 1952. The other eight will be atom-powered and their speed will be increased from 32 to 45 knots. We are already a long way from April 1949, when Secretary of Defence Louis Johnson cancelled, with a stroke of the pen, the laying down of the first 60,000-ton aircraft carrier *United States* and replaced it by B-36 super-bombers.

[2] A. de Seversky—"Air Power: Key to Survival" (English Edition p. 62). This book contains a great many criticisms of the aircraft carrier, based on fragmentary information and providing a very incorrect view of the problem.

[3] Writing on the air defence of the Middle East (INTERAVIA Review of World Aviation No. 12/1952), Arnon Aviner defined mobility as "the power to apply concentration of force rapidly at any given point." This is exactly what aircraft carriers make it possible to do.

Carrier-based aircraft were equally successful in air combat ; 6,444 Japanese aircraft destroyed in flight for 451 lost by the American carriers, a ratio of fourteen to one.

When the same naval units were operated from land bases, the casualty ratio was only six to one. It was also the same rate for the U.S. Air Force. And yet the actual aircraft, whether used on land or on carriers, were the same. What then is the secret which enabled the aircraft carrier to multiply combat results by two or three compared with the fixed bases ? It is the application of the principle of concentration in the offensive. There is nothing magical in carrier-based aviation, unless it is that the highly developed equipment of its flight deck enables it to apply the essential principles of the art of war : concentration, mobility, surprise.

The principle of equal performance

An idea current before 1939 was that carrier-borne fighters would always be inferior in performance to similar aircraft based on land. This pessimistic theory led Britain to banish fighters from her aircraft carriers in 1939 and 1940. Consequently she almost lost the war at sea in 1941.

During the same period the U.S. Navy, with greater confidence, was producing "Wildcats" and the Japanese Navy the Mitzubishi "Zero Zero" of comparable performance to the air force types of the period.

The inferior performance of carrier-based aircraft was explained primarily by the additional weight of deck landing and catapult equipment.

When aircraft were very light in weight and fabric-covered, the weight of deck landing equipment obviously represented a considerable additional load. With the increasing general weight, the rise in wing loading and more compact structure, the weight of the arrester gear has declined in relative importance.

For a "navalized" aircraft, i.e. a land aircraft converted for use on an aircraft carrier, the additional weight is provided by the arrester hook, the stronger undercarriage and reinforced fuselage, and the folding wings. This extra weight is about 300 lbs. for a 5½-ton Hawker "Fury," an increase of 2.5 percent in total tonnage. In the Hawker "Sea Hawk" (carrier-based jet aircraft) the extra weight is about 630 lbs., allowing for the addition of extra flaps and an increase in wing area. The percentage thus rises to 5 % of the gross take-off weight. This means only 15 to 20 minutes of flight.

There is much talk of increasing the radius of action of land-based aircraft, but here allowance must be made for the additional "weight of the range" which it requires in order to get back to base : the carrier-borne aircraft has its landing deck on the spot. After a few minutes of flight at sea, a land-based and a similar carrier-based aircraft are equal in estimated weight. The more fuel the aircraft consumes, the sooner equality is approached.

The "weight of the arrester gear" argument can therefore be eliminated where modern aircraft are concerned. There remains the question of a reduced speed of approach for deck landings.

As is known, the speed of take-off varies with the square root of the wing loading. This is why a carrier-based aircraft must have a lower wing loading than land-based types.[4] On the other hand, a lower wing loading gives a higher rate of climb, higher ceiling and increased manoeuvrability in the rarefied atmosphere at high altitudes. For example, the Douglas F4D "Skyray" can climb to 16,400 ft. in one minute [5] but it is obvious that there are cases where a higher wing loading must be accepted, and the designers of carrier-based aircraft must find ingenious solutions, particularly to increase the lift coefficient. The swept wing has further increased this difficulty, but American designers have countered this in the Grumman F10F by using a variable sweep wing.

The aerodynamic problems of carrier-based aircraft are undoubtedly complex, but are not technically insurmountable. The essential is to face them squarely at the design stage and not after the event. The system of building an aircraft first and foremost for land use and then "navalizing" it is a bad one. It entails two consecutive delays, the time required to perfect a pure land-based aircraft and then the time required to adapt it to carrier use.

It follows that with this method carrier-based aircraft are always behind their land-based counterparts and the Navy comes out loser in the race for performance. If, on the other hand, the carrier-based aircraft is designed as such, as is done for the U.S. Navy, naval aircraft of equal performance with land-based types can be brought out in much the same time. The system may be reversed. The F-86 "Sabre" is the swept-wing version of a 1946 aircraft designed for carrier operation, the straight-winged FJ-1 "Fury." But, it will be objected, why are the F9F "Panthers" on the aircraft carriers in Korea inferior in performance to the F-86 "Sabres ?" The reason in this particular case is the delay caused by the adaptation of the carriers to jet-powered aircraft, which had not been completed in 1950. Now, however, it is finished, and the U.S. Navy can put into service "Skyrays" or "Cutlasses," whose performance is at least equal to that of the U.S. Air Force's latest models.

The principle of precision of impact

Where bombing is concerned, the Navy's system of attacking small targets such as ships has led carrier based aviation to adopt the principle of precision of attack, instead of that of "area bombing" practised by heavy aircraft. This precision is obtained by means of compact, highly manoeuvrable aircraft, attacking in dives.

According to the official history of the American Air Force, only 13 % to 27 % of the bombs dropped by day by B-17's using the Norden sight on a circle 1,000 ft. in radius fell within the target area.

U.S. Navy statistics show that dive bomb attacks on a small target (430 sq.ft.) or a circle 23 ft. in diameter is thirty times more accurate than high altitude horizontal bombing.

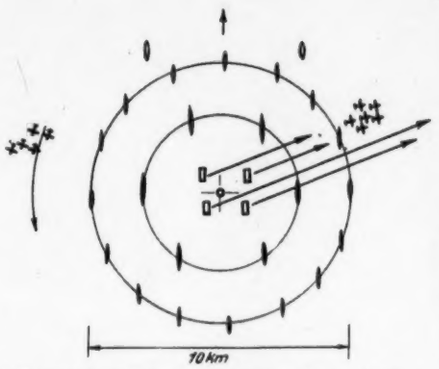
The Chance Vought F7U "Cutlass" sonic jet fighter being catapulted from a carrier of the *Midway* class.

[4] The F9F "Panther" has a wing loading 7 % lower than the F-86 "Sabre." The F6F "Hellcat" of 1945 had a wing loading 24 % lower than its contemporary, the P.47 "Thunderbolt."

[5] Compare this with the Russian MiG-15, whose low wing loading gives it a rate of climb of 10,500 ft./min. with a turbojet of moderate thrust (6,600 lbs. with water injection).

With the rocket projectile, the ratio is 480 to 1. In other words, a "Corsair" with two "Tiny Tims" has as much chance of hitting a target of 430 sq.ft. as twenty B-29's pasting the target area with 200 tons of 500-lb. bombs.

The Korean war has revealed the importance of precision of attack such as has been worked out by the U.S. Navy. This is the close air support system transferred from the battle-field. The U.S. Air Force disapproved of close air support and favoured the "strangle" principle, that is strategic long-distance attacks on the enemy's rear. This type of operation had been inaugurated in Italy in 1944 against Marshal Kesselring's rear, by the Allied Tactical Air Forces. This did not stop Kesselring taking eighteen months to retreat from Salerno to Florence. In Korea a concentrated strangle operation was carried out from August to October 1951. It did not prevent supplies from getting to the front. In November 1951, Hanson Baldwin, the New York Times' military correspondent, wrote that ground communications can only be effectively cut by occupying the area and that for this the infantry must be directly assisted by air forces used with great precision on the battle field.



Basic tactical unit in naval warfare is the *Task Group* comprising four carriers (centre), six anti-aircraft cruisers (middle ring) and eighteen destroyers (outer ring). Total aircraft strength is 350 to 400, some of them interceptors (left), others assault or escort aircraft (right).

Anti-aircraft defence by cruisers and destroyers :

54 to 60 — 6-inch or 8-inch guns
200 — 5-inch guns — 500 — 40 mm. guns
150 — 3-inch guns — 500 — 20 mm. guns

The Marines have pushed precision of attack to great lengths, since they succeed in destroying mortars less than 100 yards from the front line, whereas the B-29's (e.g. at Waegwan on 19th August 1950) cannot operate within a mile of the allied ground forces.

In close air support, the advantage of the aircraft carrier over the advanced land base is that it enables aircraft in operation to be

Deck landing by a North American AJ-1 "Savage" three-engined (piston engines plus turbojet) tactical bomber on the U.S.S. *Coral Sea*.

followed accurately by radar, and the rescue by helicopter of pilots that have been shot down to be organized rapidly.

Close air support on the field of battle does not prevent carrier-based units from taking part in strategic missions against the enemy's rear, parallel with the tactical air units based on land.

Lessons of Korea

The evolution of bombing practice in Korea from 1950 to 1953 is interesting.

In 1950, the B-29's intervened in strength

Steam Catapults for U.S. and Royal Navies

Although the use of a catapult for the launching of carrier-based aircraft dates back to mid-World War II, it has found its greatest utilization with post-war jet aircraft. For the slowly-accelerated jet fighter the catapult has become a virtual necessity if any speed in the launching of a full squadron is to be obtained. Without it, each of the jets must be placed well aft on the deck if a fully-loaded takeoff is to be assured.

Present carrier catapults in the Navies of the world use compressed air which requires complex equipment for their operation, including rams, purchase cables, a huge braking cylinder and a forest of valves, relief pipes and fittings. Replacing this complex gear shortly will be a new British-designed steam-operated catapult developed by Messrs. Brown Brothers & Co., Ltd., Edinburgh, Scotland. Conceived by Cmdr. C. C. Mitchell, RNVR, the new catapult consists of a single tube with a long slot in its upper surface. Through a novel, patented sealing system, this slot is sealed against loss of steam as the launching runner is forced down its length, carrying the attached airplane into the air. Steam is taken directly from the ship's boilers and, therefore, the necessity for separate air compression machinery is eliminated.

Tests on the new steam catapult were carried out aboard HMS *Perseus* in England throughout 1951 during which 1,000 deadweights and 126 piloted aircraft were launched to prove the practicality of the system. The *Perseus* was then brought to America and 140 aircraft and deadweight tests made during the first three months of 1952 at the Philadelphia Navy Yard, the Navy base at Norfolk, Va., and at sea. These tests showed the installation completely satisfactory, even under steam pressures that are considerably higher in U.S. Navy carriers than those used in the Royal Navy. These higher steam pressures also revealed the catapult capable of handling much heavier loads than had previously been tested.

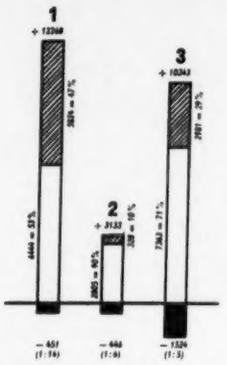
Evidence of the eventual complete conversion of the U.S. Navy to the new steam catapult is seen in the fact that production contracts have been awarded the McKiernan-Terry Corp. in Harrison, N.J., and the E. W. Bliss Co., Canton, Ohio, for quantity output. First service installation in a U.S. carrier is being made in the U.S.S. *Hancock*, an *Essex*-class carrier now undergoing very extensive modernization at the Bremerton Navy Yard, Puget Sound, Washington. Work is expected to be completed on the *Hancock* early in 1954. The *Hancock* installation will include valves, tubes and braking systems shipped from Brown Brothers and assembled with American-made parts at Bremerton.

Two of the catapults on the 60,000-ton *Forrestal*, now under construction, will use British-made parts while the other two catapults will be of entirely American manufacture, known officially as the C11-1 catapult.

The new steam catapult offers the primary advantage of accommodating aircraft of virtually any gross weight now contemplated without further changes, whereas present compressed-air equipment is rapidly approaching its capacity and completely new installations will be required. Other advantages are the greater simplicity and lighter weight of the new steam catapult as shipboard equipment and somewhat faster return of the mechanism to firing position. However, it is not expected to launch planes at any substantially increased rate since the acceleration of the catapult is determined by the particular aerodynamic and structural characteristics of the airplane being launched, and excessively-high accelerations are dangerous. As the new 15-to-50-ton carrier aircraft come into use, the new steam catapult will handle them with ease.

in the battle by day (example, Waegwan). With the entry of the MiG-15's on the scene, the bombers had to be escorted by up to fourteen fighters each (example, bombing of the Yalu airfields on November 3rd, 1951, when eight B-29's were escorted by 112 fighters). The attack on the Yalu power stations in June 1951 was made by 350 fighter-bombers (230 of them from four aircraft carriers) protected by 100 "Sabres."

Finally, aircraft carriers introduced night raids by "Skyraider" dive bombers guided by radar aircraft.



Score in the Pacific air war:
1 — Carrier based aircraft
2 — Navy land-based aircraft
3 — Army Air Force land-based aircraft

Japanese aircraft destroyed on the ground.

Japanese aircraft shot down in air combat.

American aircraft shot down in air combat.

Efficiency and economy of forces

The principle of precision bombing is gaining ground. The days have gone when air effort was measured in terms of bombs dropped : 2,700,000 tons on occupied Europe and 156,600 tons on Japan. Against this latter tonnage (for example) dropped by the B-29's, the aircraft carriers could put only 6,780 tons, but they shot down 3,749 aircraft.

It may be useful to remind the supporters of strategic air forces of the latters' losses compared with those of the carrier-based units. In Europe, RAF Bomber Command lost an average of one bomber for every 57 sorties and the USAAF one bomber for every 75 sorties.

In Japan, the B-29's lost one every 90 sorties (number of sorties 32,612). During the same period (1944-1945) aircraft carriers lost one aircraft per 2,731 sorties (703,793). What is the reason for this difference ? The fact that carrier-borne aircraft, operating in more compact formations are less vulnerable. They applied the principle of concentrated operations with close fighter escort. Altogether, compared with the strategic units, carrier-based units give a better return for the number of attacks, the hours flown, the fuel consumed and even the pilots risked. They form a weapon of higher efficiency and therefore an economical weapon from the operational point of view.

It is also an economical weapon from the point of view of logistics. The mobility of the aircraft carrier enables it to play the part of several advanced land bases.

Even in the Mediterranean where coastal bases are numerous, its economy still holds good. An aircraft carrier can, for example, provide a continuous umbrella over a convoy with *three times fewer* aircraft than land-based units.

The aircraft carrier itself is an economical arm.

The aircraft carrier and peripheral warfare

It follows from the above details that the advantages of aircraft carriers are particularly great when they are grouped in formation. A concentration of ships gives each one better protection and the naval escort will be relatively smaller.

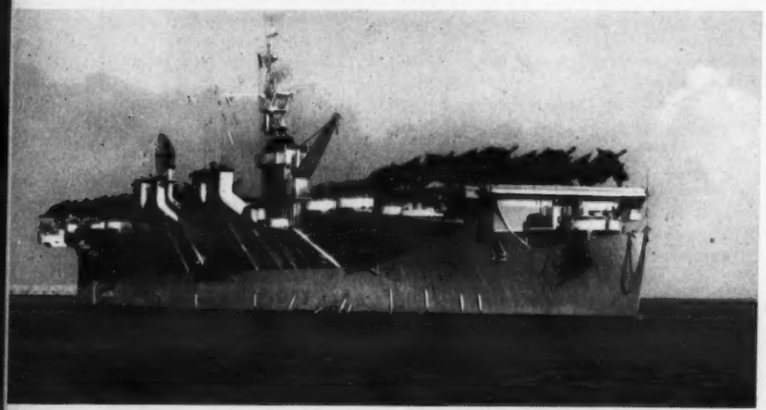
The basic formation is the *task group* of four aircraft carriers, which enables some 350 to 400 aircraft to be concentrated, with four cruisers and eighteen destroyers. Two or three task groups form a *carrier task force* with a concentration of from 700 or 800 to 1,000 or 1,200 aircraft. What land bases could group such an air force in so small an area ? In such conditions it is but a small step from the tactical field to the strategic, and it is for this reason that the aircraft carrier has become a weapon of peripheral warfare.

Admiral Radford has said that 92 % of the targets of any importance in the world are situated less than 1,200 miles from a sea coast. Consequently, they are within a 1,500-mile radius of aircraft operating from carriers 300 miles from the coast.

This gave rise to the concept of carrier-borne aircraft with a range of 3,000 miles such as the 52,000-lb. North American AJ-1 "Savage" and 65,000-lb. Douglas A3D designed for use on the *Midway* and *Forrestal* carriers.

Carrier-borne penetration and escort fighters will clear the way for the bombers, which will take the shortest route to their targets instead of the longest route which is the inevitable lot of the inter-continental bomber.

The French light carrier *Lafayette* (formerly the U.S.S. *Langley*) displacement 11,000 tons, can be used for anti-submarine operations.



Arromanches (ex-H.M.S. *Colossus*) France's second light aircraft carrier (displacement 13,200 tons) at Bizerta.

Anti-atomic deployment

It is said that the aircraft carrier is vulnerable. The first way not to be vulnerable is to be well defended.

Let us imagine a naval formation comprising four aircraft carriers, six cruisers and eighteen destroyers deployed in a circle three miles in radius, i.e. over an area of 30 square miles. It presents both a minimum of targets and a maximum of anti-aircraft defence. For the latter a total of 1,400 guns, 900 of them over 40 mm in calibre, can fire 5,000 rounds a second, i.e. 200 tons a minute. Deployed in

Grumman F9F "Panther" jet fighters on the hangar deck of the U.S.S. *Princeton*. The F9F is now being equipped for in-flight refuelling.

The "Canted" Deck

One of the classic Naval Aviation stories of World War II concerns a young British Royal Navy pilot who, after some months' duty aboard a tiny escort carrier supplied to the Royal Navy by the U.S., was ordered to land aboard one of the new, large U.S. Navy carriers. On final approach he was overwhelmed by the scene below and radiod in : "Which runway shall I use, sir !"

This story will find credence in the new 60,000-ton super carriers now under construction in America for each will have what might conceivably be regarded as four separate take-off runways. Prominent in this design, which dates back to the concept of the ill-fated *U.S.S. United States* in 1946, are two angled decks amidships to permit simultaneous launching of aircraft with the two conventional catapults at the bow.

In order to provide extensive operating experience with such an arrangement well in advance of commissioning of the *U.S.S. Forrestal*, the U.S. Navy has completed modifications to the *U.S.S. Antietam* (named after a famous Civil War battle), a 33,000-ton *Essex*-class carrier which saw service in the Pacific in World War II, and, more recently, in the fighting in Korea. The modifications were quite simple, involving only the addition of a wedge-shaped platform on the port side abeam the "island." This permitted the painting of runway markers extending from the stern at an angle of 8 degrees to port. Thus, the new "runway" starts at the stern and continues at an 8 degree angle to its termination amidships.

While at first glance this actually reduces the length of the operating runway, it simultaneously permits use of this runway while planes are parked forward on the deck. Thus, aircraft can be launched and retrieved without the necessity for clearing the forward parking area. In the event of a barrier crash, the result of aircraft tailhook failure, parked aircraft forward are not endangered. Further, in the event of a planned crash (due to failure of landing gear to come down, flaps to operate or throttle to be retarded), the stricken aircraft will move directly off the port side and into the sea or into flight again without endangering parked aircraft. Naval experts estimate that the canted deck arrangement will permit the location of some 40% more aircraft on the flight deck than in the conventional longitudinal landing area through an overlapping of parked and operating aircraft.

Although the battle for "credit" is always an onerous one, the British lay claim to the concept through the efforts of Capt. D. R. F. Campbell, RN, Deputy Chief Naval Representative at the Ministry of Supply, who developed the idea in association with Mr. L. Boddington of the Royal Aircraft Establishment. Since the idea dates back in the U.S. to 1946 it is of interest to know how long ago Captain Campbell conceived the design. However, it is certain that British reference to the arrangement as an "angled deck" makes somewhat more technical sense than the U.S. Navy term "canted deck," which conjures up the thought of planes landing up-hill or along the side of a slope.

No plans for further carrier modifications have been announced by the Navy Department but the *Antietam* deck is already undergoing rigorous tests with such brand-new aircraft as the North American FJ-2 *Fury* having been given extensive trials at sea using the new deck. These tests have already shown that the slight cross-wind created has little noticeable effect on even the slower propeller-driven aircraft.

Helicopters (Bristol "Sycamore") of the Royal Australian Navy can also be used for anti-submarine warfare. Two of these modern reconnaissance aircraft on board the light aircraft carrier H.M.A.S. *Vengeance*.

concentric formation on the surface, the ships represent only a total of 1.5 to 2 per cent of the total area, the remaining 98 to 98½ per cent being water. The immediate reply to the question of whether the aircraft carrier is vulnerable is : first of all it is very difficult to hit. Finally because of its wide deployment (distance between ships would be not less than 1½ miles) the formation would not be very vulnerable to such atom-bomb attacks as got through the defences, including the powerful interceptor units. The ease with which the Luftwaffe could attack in 1941 and 1942 is a thing of the past. The *Illustrious* in the Straits of Sicily and the *Formidable* off Crete had no fighters on board for their defence. The Japanese carriers at Midway had absolutely no radar.

Okinawa

The severest trial to which aircraft carriers have ever been put was at Okinawa, where a fleet of about twenty carriers with a total of 1,717 aircraft was employed to protect the landing of 400,000 men and was subjected for 87 days to attacks by 3,089 land-based Japanese aircraft, including 1,900 Kamikaze types. In 82 days 2,015 Japanese aircraft were shot down, 1,067 of them by fighters directed from the ships and 948 by anti-aircraft defences or crashed in suicide attacks. A classic example of a fierce battle between land-based aircraft and carriers, which ended in favour of the carrier-borne forces. Not one carrier was sunk at Okinawa, although 13 were hit during these 87 days. But 2,000 Japanese pilots were sacrificed in an effort to prove that the aircraft carrier was vulnerable. It may be recalled that Seversky had predicted just the contrary (in 1941) in "Victory through Air Power" :

a) It would be suicide for carrier-based aircraft to attempt to attack land-based units.

b) Aircraft carriers would be inviting disaster if they got within range of the land-based forces.

In spite of Okinawa, Seversky persists in his attitude and calls the submarine to the rescue against the "aircraft carrier myth." "Exercise Mainbrace" in September 1952 gave him the opportunity for noisy publicity on this subject in the London press, as one submarine (Orange) claimed to have sunk, entirely on its own, four aircraft carriers (Blue) out of six within a few hours.[6]

The aircraft carrier knows quite well that the submarine is among its principal enemies and has already gone one better by becoming in turn an enemy of the submarine. Light aircraft carriers of the *Lafayette* type form the nucleus of anti-submarine groups, known as Hunter-Killer groups, whose task is precisely to clear a given area of submarines. The modern aircraft carrier thus has a new task, that of leading the battle against submarines. The radar-equipped hunter aircraft, helicopters, aircraft with sonobuoys and killer aircraft complete the equipment of todays' carrier task force.

Although it falls into two distinct classes, "heavy" and "light," the aircraft carrier tends to cover all aspects of both air and naval warfare :

[6] This was not confirmed in the official account of the exercise. The submarine is said to have attacked *after* having been "neutralized" by the anti-submarine units.

The Aircraft Carrier

— large carriers, equipped with jet fighters and jet bombers to ensure *mastery of the air* and attack enemy targets on land (air warfare and tactical interdiction missions, attacks on airfields).

— using their control of the air, aircraft carriers can be used for the *anti-submarine* battle and participate in the *land fighting* (particularly in the case of peninsulas).

But is not Europe itself a peninsula cut off by a land front ?

The aircraft carrier of tomorrow

In the present stage of technical development the aircraft carrier of over 25,000 tons has already been adapted to take subsonic jet aircraft (Mach 0.85) ; for example, the Grumman F9F "Panther" and the McDonnell F2H "Banshee." The F9F-6 "Cougar" with swept wing, the "Panther's" immediate successor, reaches Mach 1. So does the McDonnell F3H-1 "Demon." There are also two transsonic fighters now going into service (Mach 1 to 1.2), the Chance Vought F7U-3 "Cutlass" (tailless aircraft) and the Douglas F4D "Skyray" (delta wing).

In 1953, with landings on a canted deck, it is quite justifiable to think that by about 1955 it will have adapted itself to supersonic aircraft.

The U.S. Navy is planning on a Mach number of 2 by 1960, according to Admiral Combs of the Navy's Bureau of Aeronautics.

The aircraft carriers of tomorrow will be equipped not only with supersonic aircraft but also with guided missiles. A first experiment was made in Korea in September 1952, when remote-controlled "Hellcats" were used from the *Boxer*. Guided ramjet flying bombs will increase in speed within the near future between Mach 2 and Mach 4.[7] The aircraft carrier will become the guided missile base *par excellence*.

The flight deck is tending to become wider. The American Navy was long restricted by the width of the Panama locks (100 ft.). But the aircraft carrier has had to free itself from this restriction, and the overall width of the *Midway* was increased to 136 ft. (flight deck 111 ft.). The modernized *Essex* class carriers

[7] *Aviation Week*, December 15th, 1952.

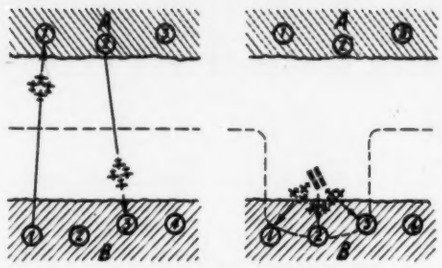
have also been widened. In the *Forrestal* the designers have not hesitated to go to 252 ft., which enables two canted landing decks to be installed. The decks have also had to be reinforced to take the vertical impact of heavier aircraft. This means armour-plating, which in turn reduces the vulnerability of the carrier itself.

The introduction of jet aircraft with a specific consumption double or treble that of propeller-driven aircraft has necessitated an increase in the size of the carrier's fuel tanks. All this has led to efforts to increase the tonnage of aircraft carriers. The *Forrestals* of 1955 will have atomic power, which will save considerable tonnage, increase aircraft capacity and, above all, speed. It is not impossible that the *Forrestal* class will have a speed of 40 to 50 knots. Their strategic mobility will exceed 1,000 miles a day.

Does this mean that in future there will be only giant aircraft carriers, and that smaller ones are doomed ?

Far from it ; the small carrier retains its value for anti-submarine missions. It will get a new lease of life by using helicopters, or convertoplanes.

However, we have not yet heard the last of the propeller-driven aircraft. Supersonic turboprop-powered machines are expected to reach Mach 1.5. The Douglas A2D "Skyshark" may shortly revalidate the light aircraft carrier, since the propeller makes for much easier landing than can be expected of jet aircraft.



The use of carrier-based units pushes forward the limit of air supremacy in intercontinental warfare.
Left : Neither side has aircraft carriers : both attack with long-range bombers. The theoretical limit of air supremacy runs at an equal distance between the two continents.
Right : Continent A uses carrier-based units, protected by ships' artillery and fighter escort, to attack targets B1, B2 and B3. The limit of air supremacy is pushed out into Continent B.

In conclusion, the era of the aircraft carrier does not appear to be drawing to an end. On the contrary, it is just beginning.

1954, the "Forrestal" era

The strategic aircraft carrier and the strategic bomber should not be set up as rivals. They are complementary.

The American error of 1948-1949 was to have regarded the B-36 with its 12,000-mile range as the sole weapon required and hence to have condemned the aircraft carrier. The performance of the MiG-15's in Korea since the end of 1950 has changed the ideas of 1949, as Convair itself went over in March 1951 from the B-36 to the B-60. In 1952 the U.S. Air Force chose the Boeing B-52, but its speed of 620 m.p.h. can scarcely give it a range of more than 3,000 miles, which means greater reliance on overseas bases. Why then not recognise the aircraft carrier, the best of advanced bases ? It will probably be possible to get better results with the 30-ton 650 m.p.h. A3Ds operating from the *Forrestal* than with 160-ton 620 m.p.h. B-52s based on Africa, Asia or Europe.

Advanced land bases pose political problems not raised by aircraft carriers, since the latter operate at sea "which belongs to everybody." It is not necessary to negotiate for bases in countries of uncertain political stability. Technical surprises too, are avoided, such as the water-logging of the runway foundations in Morocco. Finally, the policy of establishing advanced bases has yet another disadvantage, that of geographically fixed locations. Since 70% of the surface of the globe is covered by the sea, why not make use of the oceanic perimeter instead of sticking to rigid geographical axes, such as Chicago-Magnitogorsk? Air offensives mounted along too fixed an axis would lead the enemy to concentrate his fighters on this axis. Aircraft carriers enable attacks to be made on a much larger number of axes. The art of warfare boils down to being the stronger at the right place and the right time. Aircraft carriers enable place and time to be chosen at will, and thus assure superiority.

General Spaatz himself recalled in 1949 the Russians' space strategy, namely to use the vastness of their territory to lure the enemy forces well inside the country and there crush them. In the strategic air age the same space concept might cause huge losses in an offensive in depth if the latter were not supported by an adequate concentration of fighters on the spot. Mobile bases, far more than fixed bases, will force the enemy to disperse his forces and give the attacker the benefit of air concentration.

It is foolish to simplify the enemy's task, and equally foolish to limit one's own freedom of action when geographical conditions confer such freedom. In a continental war the technique of the aircraft carrier should be used to the full. The years following 1955 will more likely to be the era of the *Forrestal* than of the B-52.

McDonnell F2H "Banshee" carrier-based jet fighters from an American carrier unit over the Mediterranean. Below, the smoking volcano of Stromboli.

Today's Aircraft Carriers

The table on these pages shows what is *known* today of the world's aircraft carrier strength. The *USA* has the largest carrier armada—36 fleet carriers and 66 escort carriers: in addition, two of ten projected giant carriers are under construction. Not all of the existing fleet carriers are ready for immediate service, as a number of them are undergoing important modifications to enable them to take faster, heavier aircraft, including jet bombers.

Britain has 12 completed fleet carriers, as well as 4 maintenance and auxiliary carriers: four more are to be completed this year. The Royal Navy is reinforced by three carriers (one being converted) in service with the Royal *Australian* Navy and one carrier operated by the Royal *Canadian* Navy. The numerous escort carriers which the Americans supplied to the British under wartime "Lend-Lease" have been returned.

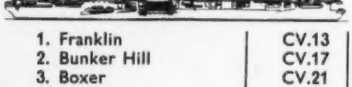
France has two fleet carriers, one built by the British, the other by the Americans. She also has a former escort carrier, now used as an aircraft transport.

Finally, the *Netherlands* Navy operates a British-built light fleet carrier.

Altogether, the West's potential carrier strength will amount to 59 fleet aircraft carriers and 67 escort carriers by the end of 1953—a respectable force.

The Russians? Soviet Russia does not seem to have paid much attention to the aircraft carrier, perhaps because Russia is traditionally a land power. However, the Russians captured the German 25,000-ton (standard) carrier "Graf Zeppelin" at Stettin at the end of the war and towed her, in damaged condition, to Kaliningrad (Königsberg) in 1947. Nothing has been heard of her since.

The Russians' apparent lack of interest in this type of naval vessel is no absolute proof of the Soviets' peaceful intentions. It is known that since the war the Russians have paid much attention to expanding their naval power by building up their fleet of submarines—the arch-enemy of the aircraft carrier.

Class and Name	No.	Builders	Completion	Displacement Standard Tons	Displacement Full Load Tons	Length ft.	Width ft.	Aircraft	Remarks
UNITED STATES									
LARGE AIRCRAFT CARRIERS (CVB)									
Forrestal Class									
1. Forrestal	CVB.59	Newport News Co.	December 1954 (Laid down 14. VII. 1952)	59,900	80,000	1,040	(252)	100+	Flush-deck type
2. Saratoga	CVB.60	N.Y. Navy Yard	May 1955 (Laid down 16. XII. 1952)	59,900	80,000	1,040	252	100+	
8 others planned: they are to have atomic power plants.									
Midway Class									
1. Midway	CVB.41	Newport News Co.	11th September 1945	45,000	60,000	968	136	137	
2. Franklin D. Roosevelt	CVB.42	N.Y. Navy Yard	27th October 1945	45,000	60,000	968	136	137	
3. Coral Sea	CVB.43	Newport News Co.	1st October 1947	45,000	60,000	968	136	137	
AIRCRAFT CARRIERS (CV)									
Improved Essex Class (Oriskany Class)									
1. Essex	CV.9	Newport News Co.	31st December 1942	30,800	39,800	888	147	100	Unknown whether all these former "Essex" Class vessels have yet been converted to "improved" "Essex" Class
2. Yorktown	CV.10	Newport News Co.	15th May 1943	30,800	39,800	888	147	100	
3. Intrepid	CV.11	Newport News Co.	16th August 1943	30,800	39,800	888	147	100	
4. Hornet	CV.12	Newport News Co.	29th November 1943	30,800	39,800	888	147	100	
5. Ticonderoga	CV.14	Newport News Co.	10th October 1944	30,800	39,800	888	147	100	
6. Randolph	CV.15	Newport News Co.	9th October 1944	30,800	39,800	888	147	100	
7. Lexington	CV.16	Bethlehem Steel	17th March 1943	30,800	39,800	888	147	100	
8. Wasp	CV.18	Bethlehem Steel	24th November 1943	30,800	39,800	888	147	100	
9. Hancock	CV.19	Bethlehem Steel	15th April 1944	30,800	39,800	888	147	100	
10. Bennington	CV.20	N.Y. Navy Yard	6th August 1944	30,800	39,800	888	147	100	
11. Bon Homme Richard	CV.31	N.Y. Navy Yard	26th November 1944	30,800	39,800	888	147	100	
12. Kearsarge	CV.33	N.Y. Navy Yard	2nd March 1946	30,800	39,800	888	147	100	
13. Oriskany	CV.34	N.Y. Navy Yard	25th September 1950	30,800	39,800	888	147	100	
14. Lake Champlain	CV.39	Norfolk Navy Yard	3rd June 1945	30,800	39,800	888	147	100	
 **Essex Class**									
1. Franklin	CV.13	Newport News Co.	31st January 1944	27,100	33,000	874	147	82-90	
2. Bunker Hill	CV.17	Bethlehem Steel	24th May 1943	27,100	33,000	874	147	82-90	
3. Boxer	CV.21	Newport News Co.	16th April 1945	27,100	33,000	874	147	82-90	
4. Leyte	CV.32	Newport News Co.	11th April 1946	27,100	33,000	874	147	82-90	
5. Antietam	CV.36	Philadelphia Navy Yard	28th January 1945	27,100	33,000	874	147	82-90	"Antietam" was first carrier experimentally fitted with canted deck
6. Princeton	CV.37	Philadelphia Navy Yard	18th November 1945	27,100	33,000	874	147	82-90	
7. Shangri-La	CV.38	Norfolk Navy Yard	15th September 1944	27,100	33,000	874	147	82-90	
8. Tarawa	CV.40	Norfolk Navy Yard	8th December 1945	27,100	33,000	874	147	82-90	
9. Valley Forge	CV.45	Philadelphia Navy Yard	3rd November 1946	27,100	33,000	874	147	82-90	
10. Philippine Sea	CV.47	Bethlehem Steel	11th May 1946	27,100	33,000	874	147	82-90	
1. Enterprise	CV.6	Newport News Co.	End 1938	19,800	25,500	827	114	85	Last U.S. pre-war carrier
LIGHT AIRCRAFT CARRIERS (CVL)									
Saipan Class									
1. Saipan	CVL.48	N.Y. Shipbld. Coy.	14th July 1946	14,500	18,760	684	115	50+	Originally "Baltimore" Class heavy cruisers
2. Wright	CVL.49	N.Y. Shipbld. Coy.	9th February 1947	14,500	18,760	684	115	50+	

Class and Name	No.	Builders	Completion	Displacement Standard Tons	Displacement Full Load Tons	Length ft.	Width ft.	Aircraft	Remarks
Belleau Wood Class									
1. Belleau Wood	CVL.24	N.Y. Shipbld. Coy.	31st March 1943	11,000	15,100	623	109	40	Ex "Cleveland" light cruisers
2. Cowpers	CVL.25	N.Y. Shipbld. Coy.	28th May 1943	11,000	15,100	623	109	40	
3. Monterey	CVL.26	N.Y. Shipbld. Coy.	17th June 1943	11,000	15,100	623	109	40	
4. Cabot	CVL.28	N.Y. Shipbld. Coy.	24th July 1943	11,000	15,100	623	109	26	Counted as "Hunter-Killer" carriers
5. Bataan	CVL.29	N.Y. Shipbld. Coy.	17th November 1943	11,000	15,100	623	109	26	
6. San Jacinto	CVL.30	N.Y. Shipbld. Coy.	15th December 1943	11,000	15,100	623	109	40	

N.B. The U.S. Navy also has 66 escort aircraft carriers (CVE) some of which were designed as such, the others converted from mercantile hulls. They are: 19 "Commencement Bay" Class; 34 "Anzio" Class; 9 "Bogue" Class; 3 "Suwanee" Class; 1 "Prince William" Class. They range from 14,000 to 24,275 tons full load. Several new escort carriers are under contract.

GREAT BRITAIN

FLEET AIRCRAFT CARRIERS

Ark Royal Class								
1. Ark Royal	Cammell Laird	End 1953	36,800	46,000	804	(113)	80-110	Two more of this class cancelled
2. Eagle	Harland & Wolff	October 1951	36,800	46,000	804	(113)	80-110	
Implacable Class								
1. Implacable	Fairfield Shipbld.	28th August 1944	26,000	32,850	766	(96)	72	
2. Indefatigable	John Brown & Co.	3rd May 1944	26,000	32,850	766	(96)	72	
1. **Indomitable**	Vickers-Armstrongs	10th October 1941	23,500	29,730	754	(95¾)	65	Similar to "Illustrious"
Illustrious Class								
1. Illustrious	Vickers-Armstrongs	21st May 1940	25,500	31,790	753	(95)	54	Armoured flight decks
2. Formidable	Harland & Wolff	24th November 1940	23,000	29,240	747	(96)	54	
3. Victorious	Vickers-Armstrongs	15th May 1941	23,000	29,110	751	(96)	54	Being converted

LIGHT FLEET AIRCRAFT CARRIERS

Hermes Class

1. Albion	Swan, Hunter	1953	18,300+	...	738	(90)	45	Four more of this class cancelled
2. Bulwark	Harland & Wolff	1953	18,300+	...	738	(90)	45	
3. Centaur	Harland & Wolff	1953	18,300+	...	738	(90)	45	
4. Hermes	Vickers-Armstrongs	....	18,300+	...	738	(90)	45	Launched 16.2.1953 angled deck
Hercules Class								
1. Hercules	Vickers-Armstrongs	Suspended	14,000	19,550	695	112½	35	
2. Leviathan	Swan, Hunter	Suspended	14,000	19,550	695	112½	35	
3. Powerful	Harland & Wolff	....	14,000	19,550	695	112½	35	For Canadian Navy
4. Magnificent	Harland & Wolff	7th April 1948	14,000	19,550	695	112½	35	Loaned to Canadian Navy
Glory Class								
1. Glory	Harland & Wolff	2nd April 1945	13,190	18,040	695	112	35	
2. Ocean	A. Stephen & Sons	30th June 1945	13,190	18,040	695	112	35	
3. Vengeance	Swan, Hunter	15th January 1945	13,190	18,040	693	112	35	Lent to Australian Navy
4. Theseus	Fairfield Shipbld.	9th January 1946	13,350	18,300	695	112	35	
5. Triumph	R. & W. Hawthorn	9th April 1946	13,350	18,300	695	112	35	
6. Warrior	Harland & Wolff	24th January 1946	13,350	18,300	695	112	35	

AIRCRAFT MAINTENANCE CARRIERS

Perseus Class								
1. Perseus	Vickers-Armstrongs	19th October 1945	12,265	16,475	695	112	35	Originally "Glory" Class. "Perseus" first vessel with new steam catapult.
2. Pioneer	Vickers-Armstrongs	8th February 1945	12,265	16,475	695	112	35	
1. **Unicorn**	Harland & Wolff	12th March 1943	14,750	20,300	640	(90)		
1. **Campania**	Cammell, Laird	7th March 1944	12,450	15,970	540	(70)		Used in A-tests near Montebello islands

AUSTRALIA

Light Fleet Carriers

Melbourne	Vickers-Armstrongs	End 1953	14,000	19,000	695	(80)	35	Royal Navy
Sydney	Royal Dockyard, Devonport	5th February 1949	14,000	19,000	695	(80)	35	Hercules Class
Vengeance	Swan, Hunter	15th January 1945	13,190	18,040	693	112	35	Glory Class, on loan from Royal Navy

CANADA

Light Fleet Carriers

1. Magnificent	Harland & Wolff	7th April 1948	14,000	19,550	695	112½	35	Hercules Class, on loan from Royal Navy
2. Powerful	Harland & Wolff	....	14,000	19,550	695	112½	35	Hercules Class, now building

FRANCE

Light Fleet Carriers

Arromanches	Vickers-Armstrongs	12th December 1944	13,190	18,040	695	112½	39-43	Formerly "Colossus" of British "Glory" Class
Lafayette	N.Y. Shipbld. Coy.	31st August 1943	11,000	15,100	623	109	40	Formerly "Langley" of U.S. "Belleau Wood" Class
Aircraft Transport								
Dixmuide	Sun Shipbld. Co.	1941	8,200	15,500	496	69½	20-30	Former U.S. escort carrier

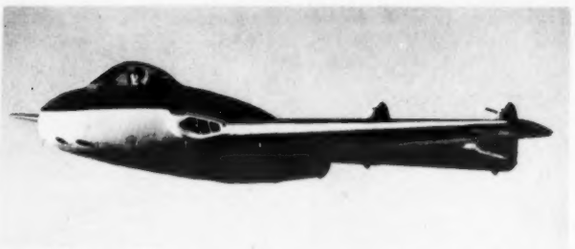
NETHERLANDS

Karel Doorman	Cammell Laird	17th January 1945	13,190	18,040	695	112½	39-43	Formerly "Venerable" of British "Glory" Class

All silhouettes by courtesy of "Jane's Fighting Ships," 1952-53, published by Sampson Low, Marston & Co., Ltd., London W.1.

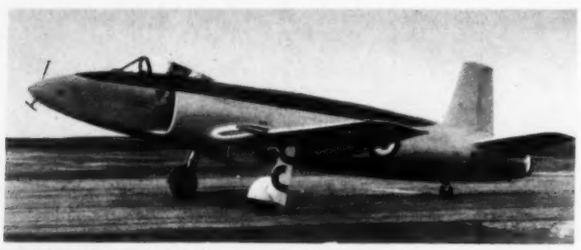
Carrier-Based Aircraft

A. Fighters

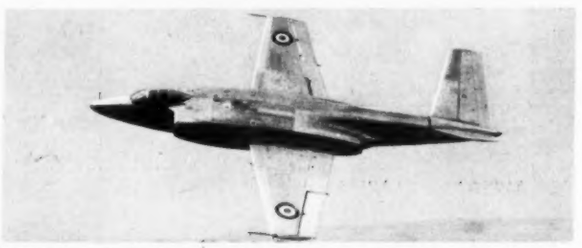


DE HAVILLAND D.H.100 "SEA VAMPIRE F.20" (GB): Single-seater fighter with de Havilland "Goblin 2" of 3,100 lbs. take-off thrust; armament: four 20-mm cannon, rocket projectiles and bombs.—Span 38 ft.; wing area 262 sq.ft.; gross weight 10,890 lbs.; max. speed 526 m.p.h. at 20,000 ft.; service ceiling 42,000 ft.; range about 760 miles.

DE HAVILLAND D.H.112 "SEA VENOM N.F.20" (GB): Two-seater fighter for day and night operations, derived from the de Havilland "Venom N.F.2" RAF night fighter.—De Havilland "Ghost" of 5000+ lbs. take-off thrust. Armament: four 20-mm cannon, rockets and bombs.—Span 41 ft. 9 in.; wing area 279 sq.ft.

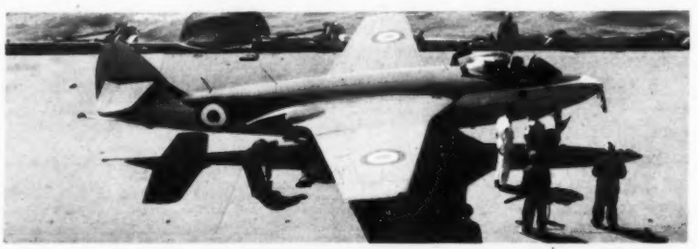


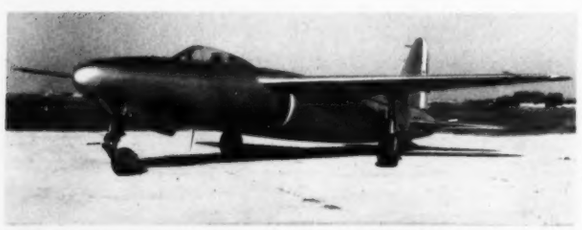
VICKERS-SUPERMARINE "ATTACKER F.1" (GB): Single-seater fighter with Rolls-Royce "Nene 5" of 5,000 lbs. take-off thrust. Armament: four 20-mm cannon, bombs or rockets.—Span 36 ft. 11 in.; wing area 226 sq.ft.; gross weight 11,750 lbs.; max. speed approx. 583 m.p.h.; service ceiling 45,000 ft.; range about 590 miles, or 1,190 miles with supplementary fuel tanks.



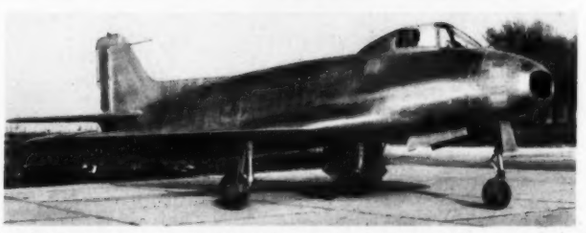
VICKERS-SUPERMARINE 508 (GB): Single-seater fighter with Rolls-Royce "Avon" of undisclosed mark of 12,000+ lbs. total static thrust. The Supermarine 508 in the picture is the prototype of the Supermarine 529 production version to be built for the Royal Navy.—Span 41 ft.; length 50 ft.

HAWKER "SEA HAWK F.1" (GB): Single-seater fighter with Rolls-Royce "Nene 4" of 5,000 lbs. take-off thrust. Armament: four 20-mm cannon.—Span 39 ft.; wing area 278 sq.ft.; max. speed about 600 m.p.h.; service ceiling about 45,000 ft.

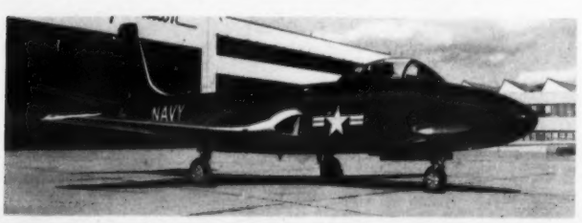




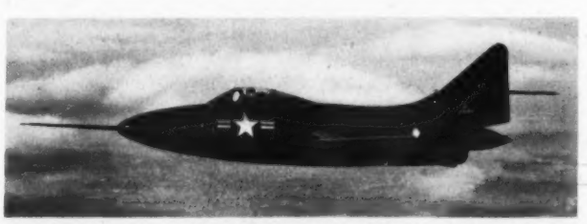
ARSENAL VG 90 (F): Single-seater fighter with Hispano Suiza "Nene" of 5,000 lbs. take-off thrust (no quantity production). Armament: three 30-mm cannon, and rockets or bombs.—Span 41 ft. 4 in.; wing area 330 sq.ft.; gross weight 17,640 lbs.; max. speed about 590 m.p.h.; service ceiling about 45,000 ft.



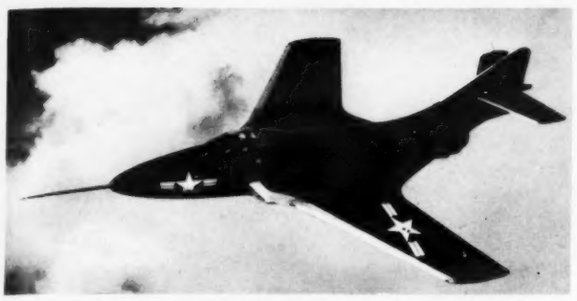
NORD 2200 (F): Single-seater fighter (prototype) with Hispano Suiza "Nene" of 5,000 lbs. take-off thrust (modifications: servo controls; radome above air intake). Proposed armament: three 20-mm cannon.—Span 39 ft. 4 in.; wing area 329 sq.ft.; gross weight 17,400 lbs.; max. speed 567 m.p.h.; service ceiling about 41,000 ft.



McDONNELL F2H-3 "BANSHEE" (USA): Twin-engined single-seater fighter with Westinghouse J-34-WE-34 of 3,250+ lbs. take-off thrust. Armament: four 20-mm cannon; probably also rockets.—Span 44 ft. 11 in.; wing area 294 sq.ft.; gross weight 20,000 lbs.; max. speed 600+ m.p.h.; service ceiling 50,000+ ft.; range with supplementary fuel tanks about 2,000 miles.

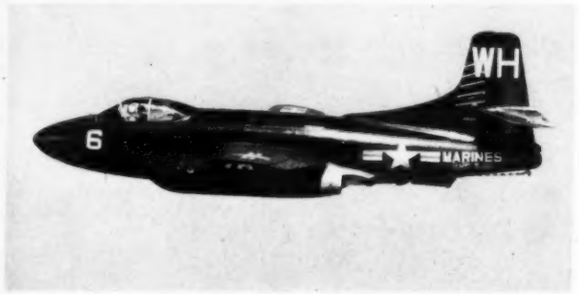


GRUMMAN F9F-5 "PANTHER" (USA): Single-seater fighter with Pratt & Whitney J-48-P-4 of 6,250 lbs. thrust (dry) and 7,000 lbs. (wet). Armament: four 20-mm cannon, and rockets or bombs.—Span 38 ft.; gross weight 15,750 lbs. or 18,500 lbs. with overload; max. speed 625 m.p.h.; service ceiling 58,000 ft.; range over 1,200 miles.

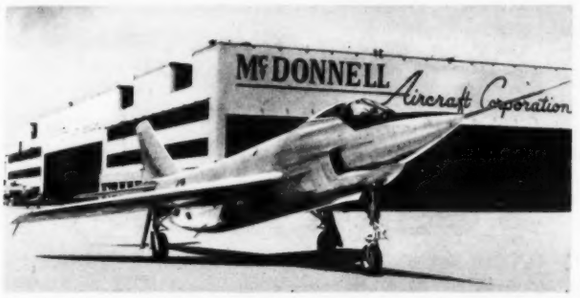


GRUMMAN F9F-7 "COUGAR" (USA): Swept-wing development of the "Panther" with Allison J-33-A-16A of 5,000+ lbs. static thrust dry, or 8,000 lbs. max. (with afterburner). Armament: four 20-mm cannon; rockets or bombs.—Span 38 ft.; gross weight 18,500 lbs.; max. speed 650 m.p.h.—A further swept-wing carrier fighter, the *F10F-1 "Jaguar,"* is under construction.

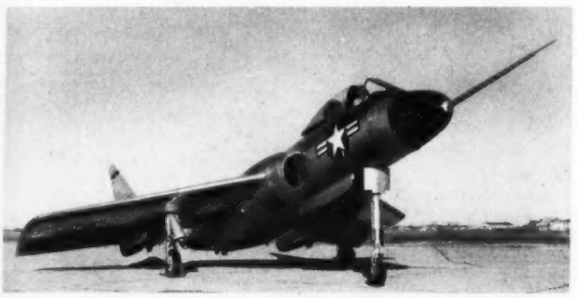
NORTH AMERICAN FJ-2 "FURY" (USA): Carrier fighter version of the U.S. Air Force's F-86 "Sabre" single-seater fighter with General Electric J-47-GE-17 of 5,850 lbs. static thrust. Armament: four 20-mm cannon; probably also rockets.—Span 37 ft. 1 in.; wing area 274 sq.ft.; gross weight 16,500 lbs.; max. speed 650+ m.p.h.; service ceiling about 45,000 ft.; range about 1,000 miles.



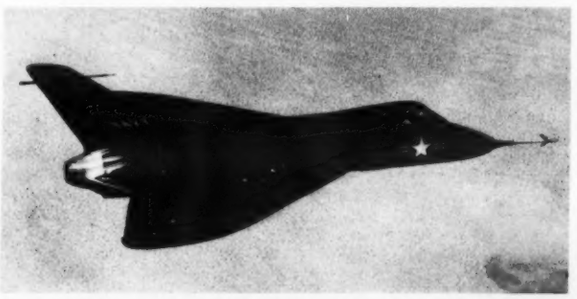
DOUGLAS F3D-2 "SKYKNIGHT" (USA): Twin-engined all-weather two-seater fighter with Westinghouse J-34-WE-38 of 3,250 lbs. thrust each (later with J-46-WE-3 of 4,800 lbs.). Armament: six 20-mm cannon.—Span 50 ft.; wing area 580 sq.ft.; service ceiling about 40,000 ft.; range 1,200+ miles.



McDONNELL F3H-1 "DEMON" (USA): Single-seater fighter with Westinghouse J-40-WE-6 (or -8) of about 7,500 lbs. static thrust dry, or 13,800 lbs. with reheat.—Span about 40 ft.; wing area about 350 sq.ft.; gross weight about 20,000 lbs.; max. speed about Mach 1 with afterburner working; service ceiling 45,000 ft.



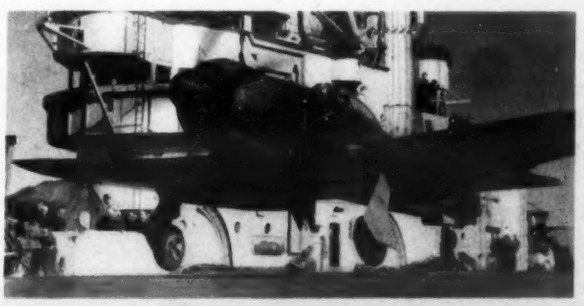
CHANCE VOUGHT F7U-3 "CUTLASS" (USA): Twin-engined single-seater fighter with Westinghouse J-46-WE-3 of 4,800 lbs. take-off thrust or over 8,000 lbs. with reheat. Armament: six 20-mm cannon.—Span 38 ft. 8 in.; wing area about 490 sq.ft.; gross weight 20,000 lbs.; max. speed 700–750 m.p.h. with reheat; service ceiling 50,000 ft.; range about 750 miles.



DOUGLAS F4D-1 "SKYRAY" (USA): Delta-wing single-seater fighter with Westinghouse J-40-WE-8 (?) of 7,500 lbs. static thrust dry, or 10,800 lbs. with reheat. Armament probably four 20-mm cannon.—Span about 50 ft.; wing area about 312 sq. ft.; gross weight about 16,000 lbs.; max. speed Mach 1+ with afterburner working; service ceiling over 50,000 ft.

B. Assault Aircraft

DE HAVILLAND D.H.103 "SEA HORNET N.F.21" (GB): Two-seater, twin-engined night fighter and reconnaissance aircraft with Rolls-Royce "Merlin 130/131" of 1,770 h.p. take-off power.—Armament: four 20-mm cannon, plus bombs, mines or range tanks.—Span 45 ft.; wing area 361 sq.ft.; gross weight 19,850 lbs.; max. speed 462 m.p.h. at 22,000 ft.; service ceiling 37,500 ft.; range 1,500 miles.

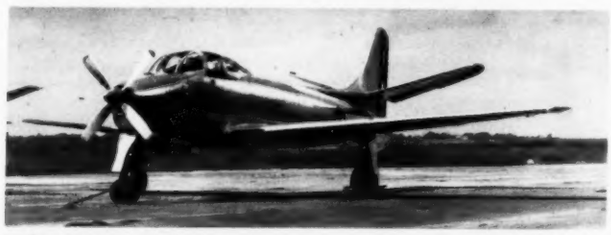


HAWKER "SEA FURY F.B.11" (GB): Single-seater fighter-bomber (also "Sea-Fury T.20" trainer version) with Bristol "Centaurus 18" of 2,480 h.p. take-off power. Armament: four 20-mm cannon, plus rockets and bombs.—Span 38 ft. 5 in.; wing area 280 sq.ft.; gross weight 12,350 lbs.; max. speed 450 m.p.h.; range 1,800 miles.

FAIREY "FIREFLY A.S.7" (GB): Three-seater carrier reconnaissance and anti-submarine aircraft without fixed armament, but with modern search apparatus. Transition model pending introduction of the Fairey "Gannet" turboprop model described below. The A.S.7 is fitted with a Rolls-Royce "Griffon" of undisclosed mark.—Span 44 ft. 6 in.

FAIREY "GANNET A.S.1" (GB): Three-seater anti-submarine aircraft with Armstrong-Siddeley "Double Mamba" of 2,950 eshp. No fixed armament, but considerable bomb load in fuselage.—Span 54 ft. 4 in.; wing area about 430 sq.ft.; gross weight about 20,000 lbs.; max. speed 400+ m.p.h.; range about 1,000 miles.

WESTLAND "WYVERN T.F.4" (GB): Single-seater naval assault aircraft and fighter with Armstrong-Siddeley "Python 3" of 4,125 eshp. Armament: four 20-mm cannon, plus rockets underneath the wings; torpedo, bombs, mines or depth charges under the fuselage.—Span 44 ft.; wing area 355 sq.ft.; gross weight about 21,000 lbs.; max. speed 450+ m.p.h.; service ceiling about 40,000 ft.



BRÉGUET 960 "VULTUR" (F): Two-seater fighter and low level attack aircraft with mixed propulsion: Armstrong-Siddeley "Mamba 3" turboprop of 1,475 eshp and Hispano Suiza "Nene" turbojet of 5,000+ lbs. static thrust.—Span 54 ft. 8 in.; wing area 463 sq.ft.; gross weight about 22,000 lbs.; max. speed about 560 m.p.h.; service ceiling about 43,000 ft.; range about 800 miles.

CHANCE VOUGHT F4U-5 "CORSAIR" (USA): Single-seater fighter and low-level attack aircraft built in several versions. F4U-5N version with Pratt & Whitney R-2800-32W "Double Wasp" of 2,850 h.p. max. take-off power. Armament: four 20-mm cannon, rockets or bombs.—Span 41 ft. 9 in.; wing area 310 sq.ft.; gross weight 13,000 lbs.; max. speed 455 m.p.h.; service ceiling 42,500 ft.; range 700 miles.

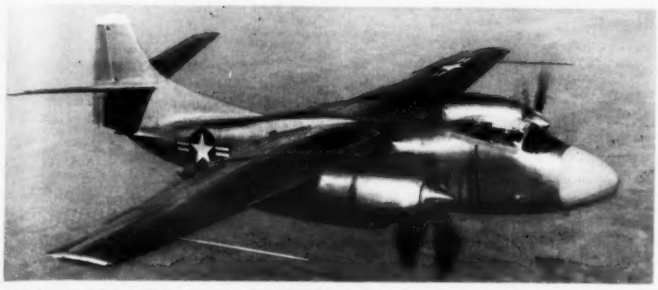
DOUGLAS AD-5 "SKYRAIDER" (USA): General purpose aircraft with Wright R-3350-26W "Cyclone 18" of 2,700 h.p. take-off power. Armament: four 20-mm cannon plus bombs or rockets according to mission.—Span 50 ft.; wing area about 400 sq.ft.; gross weight 18,000 lbs.; max. speed 365 m.p.h.; service ceiling over 25,000 ft.; range about 800 miles.

DOUGLAS A3D-1 "SKYSHARK" (USA): Single-seater naval assault aircraft with Allison T-40-A-2 of 5,500 eshp. Armament: four 20-mm cannon, plus bombs or torpedoes, rockets or supplementary fuel tanks. Span 50 ft.; wing area 400 sq.ft.; gross weight 23,500 lbs.; max. speed 525+ m.p.h.; service ceiling 40,000+ ft.; range 2,000+ miles.

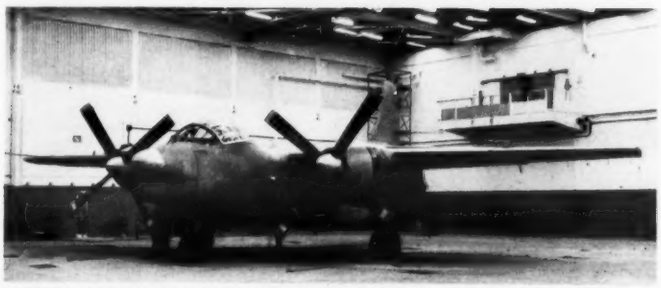
GRUMMAN S2F-1 (USA): Twin-engined four-seater anti-submarine aircraft with Wright R-1820 "Cyclone 9" of 1,525 h.p. take-off power each. No fixed armament, but up-to-date electronic search and navigation equipment.—Span about 69 ft.; wing area about 830 sq.ft.; gross weight about 20,000 lbs.—A *TF-1* training version of the A2F-1 is said to be under development.

GRUMMAN AF-2S/AF-2W "GUARDIAN" (USA): Multi-seat aircraft employed in Hunter-Killer teams for submarine detection and attack, Pratt & Whitney R-2800-48W "Double Wasp" of 2,400 h.p. take-off power.—Type AF-2W with search radar, AF-2S with torpedoes, bombs, depth charges, etc. Span 60 ft. 8 in.; wing area 560 sq.ft.; gross weight about 25,000 lbs.; max. speed 315 m.p.h.; service ceiling about 32,000 ft.; range about 1,500 miles.

C. Bombers



NORTH AMERICAN AJ-1 "SAVAGE" (USA): Three-seater bomber with mixed propulsion : two Pratt & Whitney R-2800-44W "Double Wasp" piston engines of 2,400 h.p. each and one Allison J-33-A-23 turbojet of 4,600 lbs. take-off thrust.—Span 71 ft. ; wing area about 700 sq.ft. ; gross weight about 52,000 lbs. ; max. speed 400+ m.p.h. ; service ceiling about 40,000 ft. ; range 3,000+ miles.

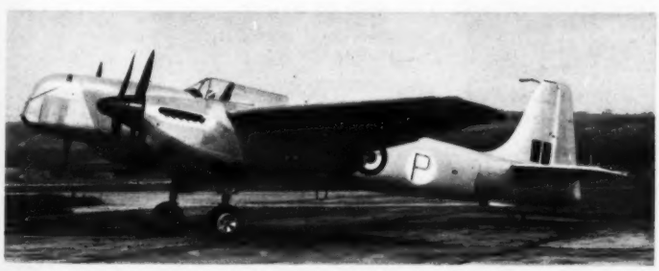


NORTH AMERICAN AJ-2P "SAVAGE" (USA): Development of the AJ-1 with two Pratt & Whitney R-2800-W "Double Wasp" piston engines of 2,400 h.p. each and one Allison J-33-A-10 turbojet of 4,600 lbs. take-off thrust. Extensive electronic equipment plus 18 cameras.—Gross weight about 55,000 lbs. ; max. speed 425 m.p.h. ; other characteristics as AJ-1.

NORTH AMERICAN XA2J-1 (USA): Three-seater experimental version of the North American "Savage" with two Allison T-40-A-6 of 5,500 eshp each. Remote-controlled defence post in tail ; bomb load 10,000 lbs.—Span 71 ft. ; wing area about 700 sq.ft. ; gross weight over 52,000 lbs. ; max. speed 400+ m.p.h. ; service ceiling 40,000+ ft. ; range 2,000 miles.

DOUGLAS A3D-1 (USA): Three-seater swept-wing bomber with two Westinghouse J-40 of 7,500 lbs. take-off thrust dry, or 13,500+ lbs. with reheat. Latest radar equipment ; remote-controlled tail defence post with two 20-mm cannon.—Span about 60 ft. ; wing area about 900 sq.ft. ; gross weight 65,000 lbs. ; max. speed 600 to 700 m.p.h. ; service ceiling 45,000+ ft. ; range 2,500+ miles.

Special purpose aircraft and trainers



SHORT "STURGEON T.T.2" (GB): Unarmed two-seater target-towing aircraft for carrier operation, with two Rolls-Royce "Merlin 140" of 1,660 h.p. take-off power each.—Span 59 ft. 9 in. ; wing area 560 sq.ft. ; gross weight 20,400 lbs. ; max. speed 365 m.p.h. ; service ceiling 38,500 ft. ; endurance 4½ hours.

BOULTON PAUL "SEA BALLIOL T.21" (GB): Two-seater trainer derived from the "Balliol T.2" shown here. Engine Rolls-Royce "Merlin 35" of 1,280 h.p. take-off power.—Details of practice weapons not known.—Span 39 ft. 4 in. ; wing area 250 sq.ft.

PERCIVAL "SEA PRINCE T.1" (GB): Unarmed twin-engined trainer with radar, radio and navigation equipment for training purposes. Derived from the "Prince" feeder-liner ; also used for liaison and transport purposes ("Sea Prince C.1" and "C.2"). Engines Alvis "Leonides 2500" of 550 h.p. take-off power each.—Span 56 ft. ; gross weight 11,850 lbs., max. speed 223 m.p.h. ; mean range 550 miles.

Is the Aircraft Carrier Doomed?

BY PIERRE M. GALLOIS, PARIS

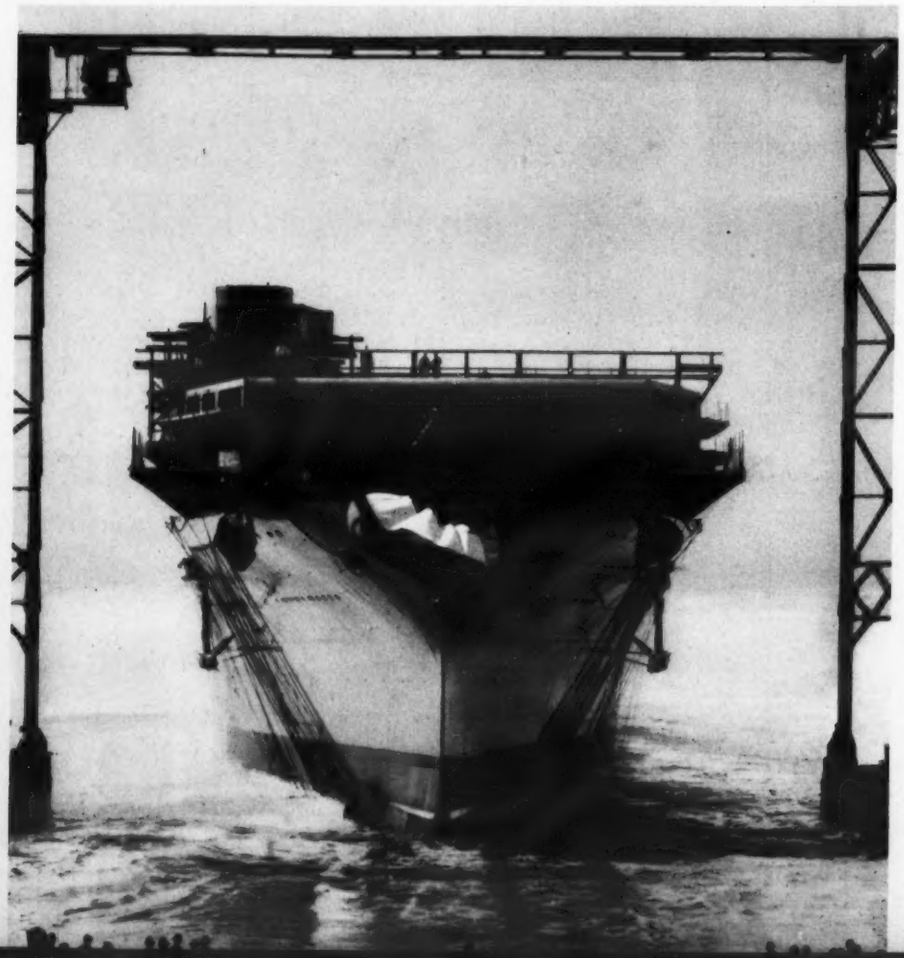
Everything was working out in the best possible way. It was no longer necessary to sacrifice good agricultural land to build costly concrete runways. Above all there was no longer any need to run the political and military risks of transforming the country into a platform for allied air operations, whether of retaliation or defence. Modern arms developments enable diplomatic prudence to be combined with national security. They spare both Uncle Sam and Uncle Joe, quieting the fears of the former without irritating the latter. With the aircraft carrier as base and the carrier-based aircraft as fighting weapons, we had the ideal instrument for protecting and pacifying the nations sandwiched between the sea powers and the land powers. Without committing ourselves in advance to any of the inconveniences of military alliances, we could still be in a position to parry any blows that were made at us. A chain of friendly airfields would appear over the horizon, anchor off-shore, unfurl an air umbrella and assure the mastery of the skies without which defence is almost impossible.

The idea was a most happy one. It pleased both politicians and military, since it provided that famous indirect protection which gives security without the necessity for haggling over its price. The world's most powerful aircraft carrier fleet provided an obvious guarantee.

But for "Exercise Mainbrace" the idea might have become an established principle. However, practical experience has somewhat upset this theory; so much so, in fact, that many people are beginning to ask themselves whether the super-carrier is not, like the battleship (in General Chassin's view), as dead as the dodo. It certainly should not be mentioned, they feel, in the same breath as the atomic gun or the robot aircraft.

The object of "Mainbrace" is well-known. By two enveloping movements, one using the northern route via Norwegian territory, and the other coming from the south up the Danish peninsula, the enemy (Orange this time) was to try and cut off Sweden, close the Baltic and occupy the west coast of Scandinavia. During the first phase of the "attack" the friendly nations had to rely solely on their own military resources, but during the second phase they called up the aid of allied powers, whose carrier forces immediately steamed eastwards. The latters' task was to clear the North Sea, provide air cover for the ground fighting, protect the arrival of the main body of reinforcements, and weaken the enemy by cutting his lines of communication with his advance forces. Thanks to the decisive support from sea and air, the situation was to be reversed. The besieged would become the attackers, and the "enemy," appalled by the 45,000 tons of the *Midway*, *Franklin D. Roosevelt* and others, would withdraw.

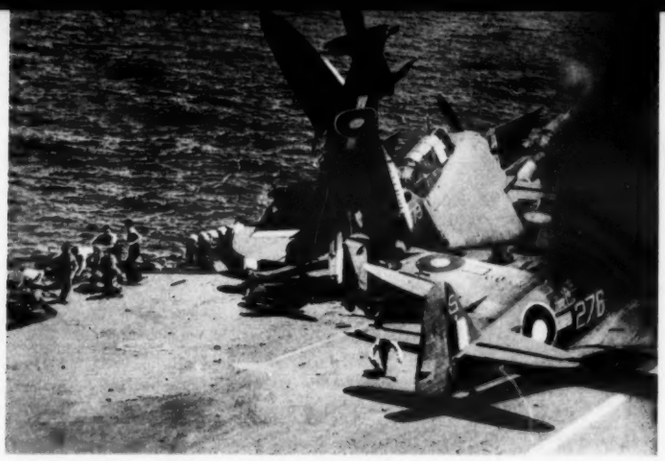
A terrific price in men, steel and capital. Launching of the American aircraft carrier, *Enterprise*.



Before the exercise everything seemed to support this theory. The two 45,000-ton American carriers practised launching and recovering aircraft day and night during their Atlantic crossing. True, one of the catapults on the *Franklin D. Roosevelt* had been damaged during the voyage and the vessel had to leave the force and put into a British port. Still, the Task Force cut a fine figure as it left the Firth of Clyde reinforced by the British carrier *Illustrious* and the large number of vessels needed to service it and the first support echelon, itself abundantly supported by other ships, etc. . . . Hanson Baldwin, on board the *Franklin D. Roosevelt*, cabled his paper the preparatory phases of the exercise and stressed the amazing modernisation of the carrier-based air fleet which was already getting rid of its piston-engined machines and would one day be equipped entirely with jet-powered aircraft. Of course, the U.S. Navy's standard attack aircraft was, and will be for several years to come, the piston-engined Douglas "Skyraider." Of course, too, the piston-engined "Corsair" still forms about half the *Roosevelt's* and the *Midway's* air fleet, but the "Cutlass" and the North American AJ are in view. And even if the latter aircraft cannot be used on board ship until the super carriers of the *Forrestal* class are completed, well, the Navy can use them from land bases, particularly if these bases are on the coasts and are swept by sea winds.

However, the winds in the North Sea were fatal to Blue's carrier-based forces, and Orange won. And winds were not the only handicaps to Blue's air activity.

Contrary to the assertions of the carrier enthusiasts, carrier-based aircraft have to be stronger, and hence heavier, than land-based aircraft, as deck landings place much higher stresses on equipment. (Photo : British Crown Copyright).



Sauve qui peut! Crash landing by a "Seafire" on a British aircraft carrier (Photo : British Crown Copyright).

Altogether, the experts say, four-fifths of the flights had to be cancelled during the first phase of the exercise, and half of them during the second. Against the Orange forces attacking the Danish peninsula, the Blue Task Force succeeded in launching no more than 300 sorties, flown incidentally by relatively light aircraft capable of remaining only about 20 minutes in the combat zone.

What had happened ?

First of all rough seas and low cloud "grounded" the aircraft on their decks. Unfortunately, not only were the land-based aircraft not immobilized by the weather, but the latter even helped them to cover their operations against the fleet. RAF Bomber Command and Training Command bombed Admiral B. Stump's flat-tops. The Royal Navy's "Hornets," more effectively based on land, were able to locate the Blue fleet and attack it, with a cloud base of 500 ft., without being detected in time. Two days later RAF B-29s operating at night and among cloud, were counted as having dropped a heavy load of TNT on the carriers without the carrier-based fighters being able to intervene.

Secondly, Orange submarines "sank" a considerable number of surface vessels. *Illustrious, Midway, Franklin D. Roosevelt, Wasp* and *Wisconsin* were "torpedoed" at point blank range and more or less neutralized.

And finally the limitations of such an enormous fleet manoeuvring in a relatively small sea (the distance between Norway and Scotland is little more than 300 miles) became more obvious than ever. Three days after the beginning of the exercise the fleet had to refuel, an operation which was not simplified by the heavy weather. At the end of the exercise, Scandinavian observers made the following general conclusions : a carrier task force cannot be employed effectively in the North Sea. The weather is frequently too bad in that part of the world, space is too limited for manoeuvres and, above all, the land bases, if held by the enemy, are too close.

To tell the truth, many had suspected as much for a long time. The famous dispute between the U.S. Air Force and the Navy in 1949 had added a great deal of documentation to the carrier's dossier. General Bradley, chairman of the Joint Chiefs of Staff, testifying before the committee of enquiry into the unification of the armed forces, described his attitude to the launching of the super carrier as follows : In examining the possible need for a super carrier he had been guided by the nature of the missions entrusted to the Navy. If existing aircraft carriers enabled these tasks to be filled, the construction of a further carrier was not justifiable . . . At the beginning of a war aircraft based on a carrier would be useful for attacking land targets before the land-based units could get into play. For this reason he agreed that a task force of carriers whose aircraft could penetrate up to seven hundred miles inland should be maintained. However, he thought that, with the exception of naval operations, the use of carrier task forces against land targets was limited . . . carriers equipped with aircraft of a longer range than those on present vessels were not necessary . . .

The various exercises carried out since then have somewhat strengthened the position of the air and land leaders. During the exercises in the Caribbean in 1949, Admiral Blandy, then in command of the American Atlantic Fleet, had to admit that his *Franklin D. Roosevelt* had been put out of action by an A-bomb raid. It must also be said that the day before the same vessel and its escort (the anti-aircraft ship *Juneau* and the destroyer *Shea*) had already been "sunk" by submarines. The exercises held off Newfoundland were even more conclusive. The surface fleet was torpedoed before it could go into action. Six aircraft carriers, the battleship *Missouri,* two light cruisers, twenty-three destroyers, about a hundred light support, supply and defence vessels, a total of forty thousand men and about 1,250,000,000 dollars worth of floating steel were deployed off Newfoundland. A mere eight submarines were enough to break up the armada and to send to the bottom—theoretically—a good proportion of the assembled ships. This was the opinion of the umpires and of Admiral D. B. Duncan.

Somewhat depressed by these successive experiences, the supporters of the flattops kept quiet up to the outbreak of hostilities in Korea. But at the end of June 1950, when the U.S. Air Force's aircraft based on Japan did not have sufficient range to fly continuous operations over the peninsula, the Navy's twenty-four Chance Voughts, operating from the U.S.S. *Sicily,* filled in the gap until land bases could be constructed. Then, one by one, four large carriers were sent to Korean waters. And aircraft from the *Leyte,* the *Valley Forge,* the *Philippine Sea* and the *Boxer* began piling up sorties. Thus, as Léon Schloss wrote in "Aero Digest," the lessons of the war in Korea should contribute towards the renaissance of carrier-based aviation. Although the Navy had been reduced, for economy reasons, from 103 to 15 aircraft carriers, it threw itself into the battle, forgetting the decisions of Key West and Newport.

However, if the Korean fighting has undoubtedly turned to the advantage of naval aviation, this is because the carriers are not threatened by either submarine or air attack. It will be agreed that these are rather special conditions and that, but for their dimensions, gondolas or triremes would be just as useful. In fact, an American expert, a partisan of the aircraft carrier, condemns their tendency to excessive size and claims that the Korean war has left us one great lesson, namely never to discard a weapon because its usefulness is not immediately apparent. Special circumstances may always arise which may necessitate its use. This reduces the aircraft carrier to the level of a weapon for localized conflicts. It throws it out of the arsenal designed for global warfare and relegates it, with the mortar, the piston-engine aircraft and the Molotov cocktail, to the "luke-warm" wars, such as Korea and Indochina. It is thus moved from one hierarchy to another and can have its tonnage, complexity and cost reduced without losing any of its efficacy for its new missions.

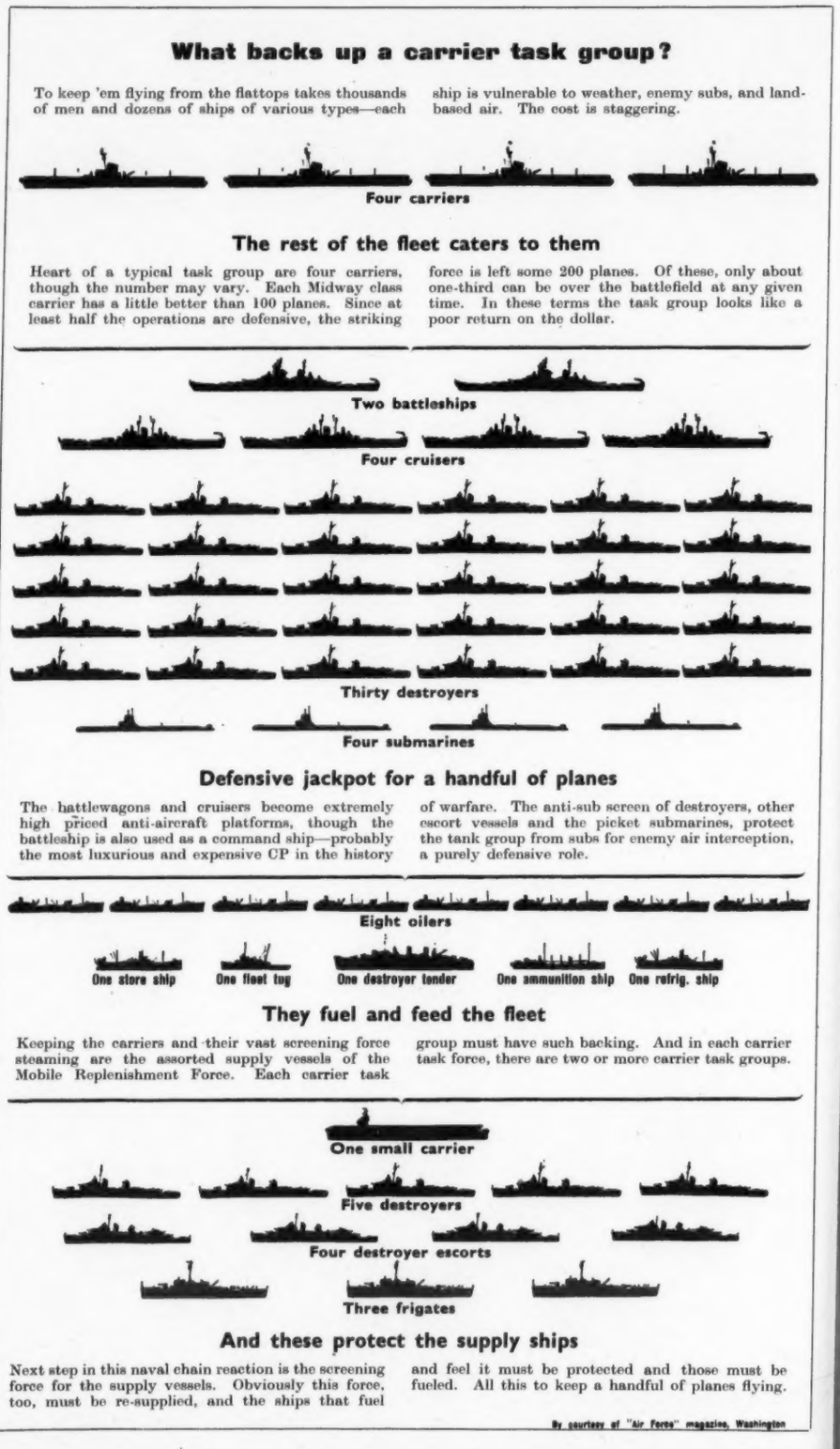
What exactly is a carrier fleet? By today's conventional standards, four heavy carriers, each carrying a hundred and twenty aircraft (40% of them for the defence of the carriers themselves), can line up some three hundred

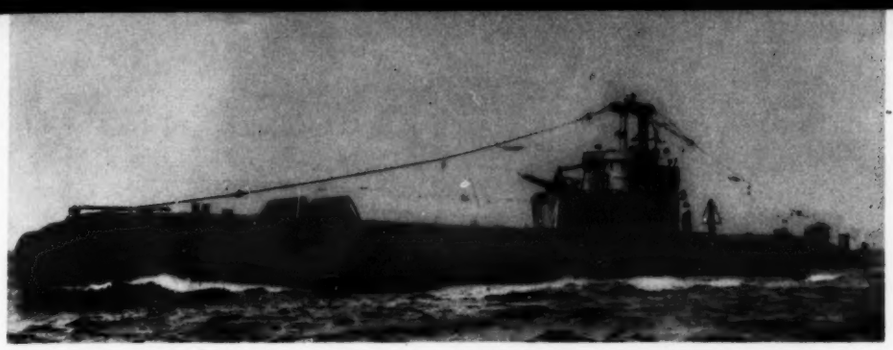
machines of under 15 tons in weight. But floating bases also require powerful protection against surface and under-water threats. Two battleships, for heavy artillery and administration, four cruisers, about thirty destroyers, four submarines surround the four flattops. To supply the whole, eight oilers, one store-ship, one workshop ship, and ammunition ships are required. These servicing vessels in turn need to be if not serviced themselves at least protected by about fifteen additional vessels, from the small carrier to the destroyer escort. All this costs a terrific price in men, steel and money.

Alexander de Seversky[1] stated that Task Force 58, which dropped 513 tons of bombs on Japan, comprised sixteen aircraft carriers, eight battleships, seventeen cruisers, seventy-five destroyers and, of course, through the chain reaction described above, a large fleet of floating servants, themselves protected and supplied by additional equipment. Altogether it took 100,000 men and an investment of $3,750,000,000 to release these 513 tons of bombs. The attack lasted three days and 10% of the forces engaged were lost. At the same period and during the same three days, 167 B-29's of the 20th Air Force based on the Mariannas dropped 1,220 tons of bombs on Japanese cities. To get this result the 20th Air Force had only half as much personnel and used equipment ten times less costly. Later calculations were even more eloquent. Every time the American taxpayer spent $250,000 on B-29's and their bases twenty-three tons of explosives fell on Japan. For the same sum naval aircraft dropped 1,550 lbs. or thirty-three times less.

Of course, the U.S. Navy says that its carrier-borne units destroyed 12,300 Japanese aircraft during the Pacific war. And that 93% of these were land-based aircraft. However, it was only after the American air forces—both Army and Navy—had pounded the enemy's air arm and razed its industry that destruction in air combat turned into a holocaust. It must also be said that the American land-based units, with their B-17's, B-24's and B-29's succeeded in dropping 157,000 tons of bombs on the Japanese archipelago, whereas aircraft operating from American carriers totalled barely 6,800 tons, or only 4% of the total. It is even possible to write—as has been done—that the war in the Pacific was won by the twenty thousand tons of projectiles dropped from the Navy's aircraft carriers on both land and naval targets. This statement does not survive even cursory examination. If the "Enola Gay" with the world's first atom bomb had taken off from an aircraft carrier the history of the war would doubtless have been changed and the admirals would have tried to pass off the flattop, in spite of its vulnerability, cost and low efficiency, as the decisive weapon, the floating B-36, the ultimate resource if the irremediable happened, i.e. if a global war broke out. But the "Enola Gay" took off from *terra firma*. Finally, it can be affirmed—and this too has been done—that if during the same campaign land-based bombers dropped nearly a hundred times more explosives than their naval counterparts, theirs is a blind force and their destructive effects more unequal. To compare the precision of dive bombing by carrier-based fighters with the area bombing of the "Flying Fortresses" and "Super Fortresses" is like comparing a fire cracker with an earthquake ; and at the same time to belittle the enemy's fighter and anti-aircraft defences. Those who raided the Ruhr and Berlin cannot

[1] In "Air Power : Key to Survival."


What backs up a carrier task group?
To keep 'em flying from the flattops takes thousands of men and dozens of ships of various types—each ship is vulnerable to weather, enemy subs, and land-based air. The cost is staggering.
Four carriers
The rest of the fleet caters to them
Heart of a typical task group are four carriers, though the number may vary. Each Midway class carrier has a little better than 100 planes. Since at least half the operations are defensive, the striking force is left some 200 planes. Of these, only about one-third can be over the battlefield at any given time. In these terms the task group looks like a poor return on the dollar.
Two battleships
Four cruisers
Thirty destroyers
Four submarines
Defensive jackpot for a handful of planes
The battlewagons and cruisers become extremely high priced anti-aircraft platforms, though the battleship is also used as a command ship—probably the most luxurious and expensive CP in the history of warfare. The anti-sub screen of destroyers, other escort vessels and the picket submarines, protect the tank group from subs for enemy air interception, a purely defensive role.
Eight oilers
One store ship
One fleet tug
One destroyer tender
One ammunition ship
One refrig. ship
They fuel and feed the fleet
Keeping the carriers and their vast screening force steaming are the assorted supply vessels of the Mobile Replenishment Force. Each carrier task group must have such backing. And in each carrier task force, there are two or more carrier task groups.
One small carrier
Five destroyers
Four destroyer escorts
Three frigates
And these protect the supply ships
Next step in this naval chain reaction is the screening force for the supply vessels. Obviously this force, too, must be re-supplied, and the ships that fuel and feel it must be protected and those must be fueled. All this to keep a handful of planes flying.
By courtesy of "Air Force" magazine, Washington



The aircraft carrier's natural enemy, the *submarine*. The British submarine *Sanguine* in the Mediterranean.

help smiling at the thought of the fighter-bomber coming along at 3,000 ft., tipping over into the vertical and aiming at a power station or the fuel dump of a factory in a heavily defended industrial area. In fact, nobody now takes this passionate but clumsy defence of a lost cause seriously.

The North Sea is "too small" for aircraft carriers to manoeuvre in safely, the experts declared after "Exercise Mainbrace." And land bases are so close that flattops and their air fleet, too often immobilized by the wind, bad visibility or even catapult breakdowns, must inevitably be exposed to mortal danger.

What about the Mediterranean, if not for its weather conditions at any rate for its narrow dimensions ? The carrier advocates put forward the example of Okinawa and the successes scored there by floating bases in a narrow sea. But they forget that the operation took place in the spring of 1945, that is to say after the enemy air forces had been destroyed and when they had fallen back on the *Kamikaze* corps. The other argument generally advanced is that the carrier can halve (at any rate theoretically) the distances to be covered and thus give its aircraft the advantage of lightness in weight over land-based aircraft with their greater range and consequently heavier fuel load. But this is to ignore the extra structural weight of all carrier-based aircraft. Whatever may be said to the contrary, deck landings always necessitate a heavier structure than in equivalent land-based aircraft.

A glance at a map of the Mediterranean shows that its peninsulas and islands have a greater strategic interest than the most imposing floating bases that Admiral Gallery can think up. And nobody would deny that if these islands and peninsulas were to fall into enemy hands, aircraft carriers would be very little safer here than in the Caspian Sea, or Lake Baikal. Naturally, in times of peace or of cold war nothing adds more to the prestige of the nation or group of nations that possesses it than a powerful combat fleet organized around three or four aircraft carriers. Who, on visiting the Riviera, has not been impressed by the vessels of the 6th Fleet and by the luxury and power of their combat equipment. But at the moment, the Mediterranean is free from all air and submarine menace.

Tomorrow too will bring new technical equipment with which it can be guarded. Its dimensions are small enough and the high points in the territory surrounding it are close enough for the guided missile to replace the land-based aircraft and thus relegate the aircraft carrier to the company of the three-master and the slingshot.

This criticism applies to the value of the aircraft carrier in a generalized conflict and operated in a theatre now considered to be unfavourable to its use. Doubtless, it does not apply to the same extent in localized conflicts. Where geographic conditions enable aircraft carriers to enter the lists and the enemy can offer no air or submarine resistance, nothing equals the mobility of these floating platforms. If the Korean war has increased the confidence of the flattop partisans, it is because it has provided ideal conditions for its use. A narrow peninsula, absence of enemy air operations, no enemy submarine activity, proximity of the Japanese islands and the centres of technical supplies, close support provided in skies where there are frequently no enemy aircraft capable of operating at low altitude, all these factors have brought out the advantages of the aircraft carrier and its fighter bomber, even those with piston engines. Without wishing to belittle the value of such naval air strategy, it should be added that the enemy did not stint on the equipment thrown into the battle or count his losses. And also that Korean territory, at any rate at the beginning, was not prepared for the development of a land-based air force.

If the same conditions recur, aircraft carriers will be used again with profit during the early phases of a similar conflict. But it is not necessary to increase their displacement to sixty thousand tons for them to play such a role. If localized warfare and sub-atomic combat become one of the chronic forms of hostility between East and West, the aircraft carrier will have to be adapted to its new mission and be stripped of its equipment for combat on the high seas in global warfare, such as the war in the Pacific. Admittedly it will lose in impressiveness but will not sacrifice its efficiency. It will be obeying the same laws of simplification and economy which are beginning to make themselves felt today in certain aircraft programmes. Thus adapted to the new requirements of localized wars, the flattop will be able to survive the atomic age, for the good reason that it will no longer be designed to stand up directly to its effects.

In "luke-warm war"—Korea and Indochina—aircraft carriers can render valuable services without being over-sized. The U.S.S. *Boxer* (with "Panthers" and F-51 "Mustangs") in San Francisco harbor ready to sail for the Far East.

Fairey "Firefly Mk.5" two-seater naval reconnaissance and anti-submarine aircraft on board H.M.A.S. *Sydney*. Armed with four 20-mm cannon and up to 16 rockets (or bombs, depth charges and sonobuoys), the "Firefly" is in service with the navies of four countries.

Let's talk sense about the Aircraft Carrier

BY COMMANDER B. J. HURREN, LONDON

Talks by intelligent people on British radio services, and reasoned articles by sane citizens in the more serious magazines, backed up by stunt displays in the popular Press, have—during past months—indicated a definite trend which may be summarised as—"We are losing the power of thinking."

This virus is particularly to be noticed in the world aeronautical. "Intelligence" becomes so easily synonymous for "technician"; in place of a brain we tend to worship the false gods of storage-of-information. A walking encyclopedia of aviation data, facts, figures and what-have-you is regarded as brilliant, but the thinker who rightly views these things as ephemeral and who clearly sees that the efforts of leading technicians are devoted to blowing us all to smithereens—he remains in the shadows, with the lonely solace of an Epicurean philosophy.

The truth of all this is, perhaps, nowhere more evident than in that green sore of contention which is termed Aircraft Carrier. It is extraordinary how much hot air is generated by the aircraft carrier, whilst the degree of sloppy thinking on the subject is beyond computation.

In this article I do not propose to reiterate a mass of statistics concerning carriers and their fighting equipment : that can be readily obtained from first class reference books or any of the many walking encyclopedias. What I want to consider is simply this : *Does the aircraft carrier justify its existence ?*

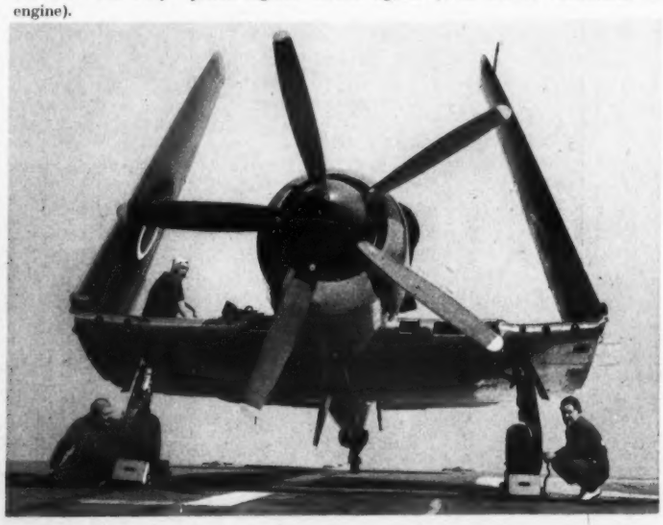
The arch-opponent of the aircraft carrier is the Russian-born, American aircraft constructor and now air strategist, Major Alexander de Seversky. All his arguments boil down to proving that the aircraft carrier is a dead duck vis-à-vis the land-based bomber.

When, in refutation of this, the case of the extended war in Korea is quoted, he and his followers wag an admonitory finger and pronounce : Ah, but there is no opposition in Korean waters.

But who said there was ? And how is that relevant ? What might happen there if the aircraft carriers were opposed by land-based air forces is so much smoke in the eyes, for the simple reason that the question has not arisen. Stacks of statistics indicate what carrier after carrier has actually done in Korea alone ; is all this vast body of favourable evidence to be discarded because, had other circumstances

The Fairey "Gannet" propeller turbine anti-submarine aircraft (here the two-seat prototype) can fold and unfold its wings even when its contra-rotating propellers are running.

Hawker "Sea Fury" piston-engined carrier fighter (with Bristol "Centaurus 18" engine).



prevailed, it is argued and alleged but not proved they could not have done it?

That approach seems to me the ultimate in sloppy thinking. It is one of the oldest tricks—exercised even before printing began—to put up a false argument and then brilliantly demolish it yourself.

The next line of anti-carrier argument runs to this effect: The bomber can span the world, and carrier aircraft have only a very limited range. Hence, the bomber can command the seas, and there is no use for a Navy and especially Naval Aviation. Very pretty, eye-catching diagrams are produced to explain all this, and, as with all diagrams, they are set down in three dimensions.

Unfortunately for these arguments the question is one of four dimensions: *time is the extra factor*. What is wanted, in an action against submarines or in covering a sea-borne landing, is air cover, air support, and air attack *at the exact place at the exact time*. If, when occasion for battle offers against a submarine pack, the aircraft carrier is in the middle of the Atlantic and its aircraft have a range of, say, only 100 miles, then it is not only irrelevant but plainly absurd to say that bombers based on land some 1,000 miles away can deal with the situation as effectively as those from the carrier on the spot.

Let me hammer home this Time factor. The British had to wait a long while to trap the Italian Fleet at Matapan in the early spring of 1941, and the period of battle at the end of March of that year was brief and decisive: so decisive that it was not until hours later that the first enemy bomber appeared—hours after the critical phase had passed and the balance of power in the Eastern Mediterranean irredeemably altered.

The same applies to the great three-day air-sea battle of the Coral Sea at the beginning of May, 1942, a turning point in the war. That battle was fought by carrier aircraft on both sides, Japanese and American. It is plain nonsense to argue that land-based bombers could have fought a better battle, and so on *ad nauseam*. It reminds me of that charming quatrain:

> "Safe upon the solid rocks
> The ugly houses stand;
> Come and see my shining Palace
> Built upon the sand!"

Since we are courageously embarking on a mental dose of salts, let us make this positive point: *we are talking about War*. The fact that at Farnborough, say, a thing of exquisite grace

Catapult take-off by a Hawker "Sea Hawk" from the British carrier H.M.S. *Eagle*.

and aerodynamic perfection shoots through the sky at seemingly meteoric speed is not the slightest indication that it is a warplane. The Naval Staff virtually could not care less about grace, line, design, and technical tricks: what the Staff wants is something with which to fight and overcome the enemy. Crudely put in another way, a wallowing old Swordfish biplane *in certain circumstances* is still today, in 1953, far superior to any Neptune, Skyraider or what-have-you, and the converse is equally true.

Subject to correction, I believe I am right in stating that there were no fewer than 209 versions of the Hurricane fighter, which was a sensation when it first appeared in 1935. That fact emphasizes the Hurricane's value as a warplane for War requirements of a flexible and unpredictable development when it first appeared. Its power was doubled during its "life" and, in one of its phases it became "navalised" as the Sea Hurricane.

The only reason it was able to be used over the sea far from land was that it found an equally flexible means of war in the shape of the aircraft carrier.

The Staff can be wrong; often is wrong. It was wrong in its pre-war assumption that the

A "Sea Hawk" coming to a standstill after a relatively short run.

The three-seater production version of the Fairey "Gannet" propeller turbine anti-submarine aircraft in flight.

aircraft carrier would immediately fall a victim to the bomber. In fact, no British carrier was sunk purely by bomber : it was the torpedo which did the most damage. (American carriers were sunk by bombing : the explanation is too involved to be logged here.) And when the Staff realised it was wrong, it rapidly profited by the flexibility of the carrier to bring off such outstanding *coups* as Taranto, the *Bismarck*, and so on.

What is this "Staff" which puts its faith in the carrier—the carrier which the Seversky school regards with patronising contempt if not fallacious ridicule ? In Britain, on the naval air side, the head is the Fifth Sea Lord ; under him, the Director of Air Warfare heads perhaps the most important air division in the Admiralty. Both have had long flying careers. Under the Fifth Sea Lord are literally scores of officers with war experience in every part of the world, and, not least in importance, with the U.S. Fleets. At their disposal is a small army of scientists and advisers : the current Navy List shows about 1,000 names in the Royal Naval Scientific Service, and though many of these are not purely with naval aviation, it is clear that the Staff can call on first class technical brains.

And behind all this is Industry. The number of first class technical and experienced advisers in Industry is incalculable. Industry works very closely with the Admiralty and Ministry of Supply.

Does all this great body of truly expert opinion count as nothing in the scales as against the specious arguments of the anti-carrier-cohorts ? The notion has only to be put on paper to be graded as fantastic.

The specific task of the Royal Navy is to maintain sea communications. The aircraft carrier is one of the means employed in this critical task ; and, in the view of many, is the all-important means.

It has been clearly shown in two Wars that the submarine is by far the greatest menace to sea communications. The bombers of the enemy had unlimited opportunities to better the destruction effected against merchant shipping by the submarine (aided by the torpedo) but the figures show that the U-boat was infinitely more to be dreaded than the bomber. After all, the U-boat is yet another classic example of War use : to be at the right place at the right Time.

The question therefore is : Can a better means of protecting ships on the high sea be found than the aircraft carrier ?

At once, the anti-carrier brigades rush into action. Results achieved in the last War are quoted : the score is that shore-based aircraft alone accounted for 245½ U-boats, and ships (exclusive of aviation) for 247. For interest, carrier aircraft (44) and ship and shore-based aircraft (32) come third and fourth in priority, together aggregating 76 U-boats.

That is the truth : but it is not the whole truth and nothing but the truth.

The question really concerns not the number of sinkings of U-boats, *but whether the convoys got through.* And the secondary question is : Did the aircraft carrier play a key role in this or not ?

The answer is Yes to both questions. No fewer than 75,000 merchant ships were escorted across the Atlantic in 2,200 convoys. The average, as seen by the U-boat-command, was 1 sinking out of every 131 ships that made the Atlantic passage.

Now to revert to the figures of 245½ and 247. It is irrelevant how many submarines are sunk or not sunk *provided the convoys get through.* In other words, the enemy can have 10,000 submarines at sea, or in port : let him have them, willingly, provided they don't interfere with our shipping. Hence, quite logically, the very fact that the aircraft carriers only sank a few of the total of 781 is paradoxically absolutely indicative of the value of the carrier : it is, in effect, a statistical revelation that the U-boat commanders said : "Boys, when there is a carrier about, the best thing to do is to vanish quickly." That shore-based aircraft and ships (exclusive of aircraft) brought about so many sinkings is a plain indication that the U-boats decided that they would risk attacking if no carriers were about.

Alternatively, since figures are like soldiers and can be ordered to Form Fours at will, the statistics of sinkings should be integrated with the number of ships in being, the number of shore-based aircraft employed, the number of sorties and so on—and then match those figures against the same figures from the carriers. This has never been openly attempted : but there is no doubt whatever in my mind, after a preliminary estimate, that were they to be released the facts would come down heavily in favour of the carrier.

The extent to which the anti-carrier advocates will go sometimes makes one pause in admiration. I quote the following from the British aviation weekly, *Flight :*

> "Speaking at the Convertiplane Congress in Philadelphia recently, Dr. J. Bennett said that a helicopter tug beneath which a fixed-wing aircraft would be attached, could be used to assist the take-off and landing, thereby eliminating large airfields. He explained that the tug would lift the fixed-wing machine into the air and release it at a forward speed within the speed range of both types . . . Doctor Bennett expressed the opinion that large aircraft carriers at sea would thus be rendered obsolete . . ."

No comment, please.

It was comedian Will Rogers who put his finger on the U-boat menace, and provided a perfect defence solution. "I've discovered," he asserted, "that submarines can't exist in boiling water. So, all you have to do is to heat up the sea to boiling point." Asked how to do this, he replied reproachfully : "I give you the big ideas, Boy, it's for you to work out the details !"

The aircraft carrier has many disadvantages, but considered opinion is that its advantages far outweigh them. The great thing to do is to keep a clear head on the subject and, above all, respect the professional judgment of the fighting men who go to War in them. Eschew the amateurs—especially those with a bomber in the Bonnet !

The U.S. Navy's "Forrestal"-Class Carriers

The United States Navy now has under construction the two largest naval vessels ever built. Significantly, both are aircraft carriers and will symbolize completion of the naval revolution launched in World War II in which the aircraft carrier has replaced the proud and mighty battleship as the "capital" ship of a fleet. Thus has Naval Aviation ultimately emerged as the preeminent weapon in sea warfare, matching its land-based counterpart in authority over combat.

Projection of these monster vessels, shortly after V-J Day, generated a storm of controversy in the U.S. fully equaling the size of the carriers in their respective field. It was all touched off by a gigantic, if natural, public relations error on the part of the Navy Department. The history of aircraft carrier development progress in the U.S. Navy, as in other navies, has been a logical progression in size and capacity from the tiny *U.S.S. Langley* of the World War I era to the huge 45,000-ton *U.S.S. Midway*-class of late World War II. It followed that the next stage in carrier design would logically be a 60,000-ton class and this proved to be the case with the Navy's request for Congressional approval for construction of the *U.S.S. United States* in 1947.

This design for the largest ship in the world was accompanied by an integrated program for the development of heavy, multi-engined carrier aircraft. The *United States* was to be 1,090 ft. long, 130 ft. wide, provide 280,000 shp and displace 80,000 tons under full load. The Congress approved funds for the start of construction. The contract with the Newport News (Va.) Shipbuilding and Drydock Co. was signed August 10, 1948, and the keel was laid with appropriate ceremonies April 18, 1949. Just five days later it was unceremoniously cancelled by Secretary of Defense Louis Johnson in one of the boldest exercises of executive authority in U.S. administrative history. The legal question involved was whether Johnson held authority to cancel a project which had been approved by, and funds provided for, by the U.S. Congress.

What had actually launched the controversy (although many other factors were involved) was the Navy's repeated reference to the projected vessel as a "super carrier," which connotated a weapon of extraordinary importance—and so it became in the minds of economy-bent legislators and administrators. Had the Navy confined its references to the ship as the logical, orderly development of the type, many believe the storm of criticism would never have arisen. This action, together with several others, played a major part in the 1949 "revolt of the admirals," the ensuing Congressional investigation and the ultimate firing of Johnson in one of President Truman's most difficult periods of administration.

For two years the Navy kept its peace, while quietly designing a slightly smaller (100 tons) carrier, the *U.S.S. Forrestal,* named for the late, revered, Secretary of the Navy and, later, Defense. Conditions of the request for construction funds for this vessel were entirely different than for the previous giant carrier. No references were made to the new vessel as a "super" ship, the pressures and dangers of the Korean war were at work and the days of the stringent economy of 1948 were well past. Therefore, the Congress approved the Navy's request and the keel for the *U.S.S. Forrestal* was laid at Newport News July 14, 1952. Funds were also requested for a second huge carrier, the *U.S.S. Saratoga,* in the fiscal 1953 budget and these, too, were approved. The contracts were let and the keel of the *Sara* was laid with ceremonies presided over by Secretary of the Navy Dan Kimball at the New York Naval Shipyard on Dec. 16, 1952.

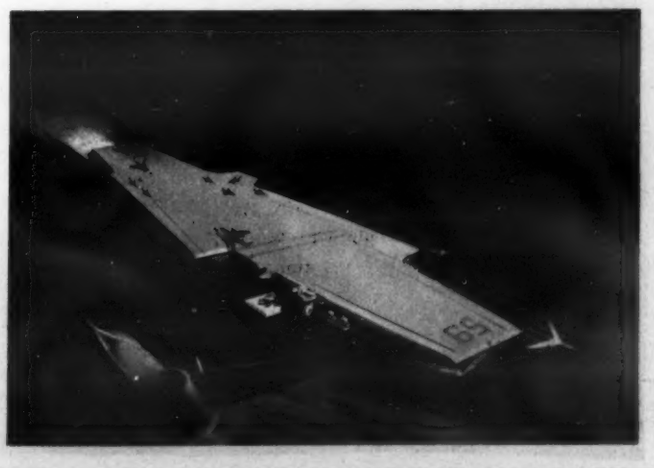
The 59,900-ton carriers will be sister ships with an overall length of 1,040 ft. and a beam of 252 ft. This unprecedented beam will prohibit their passage through the Panama Canal, a dimension which the Navy has carefully avoided exceeding in the past fifty years for obvious reasons. The *Forrestal* will cost $218,000,000 but the *Sara,* because she is near-identical, will cost only $209,700,000. Both monsters will, in the Navy's conservative public language, accommodate "more than 100 planes" and have a top speed "in excess of 30 knots."

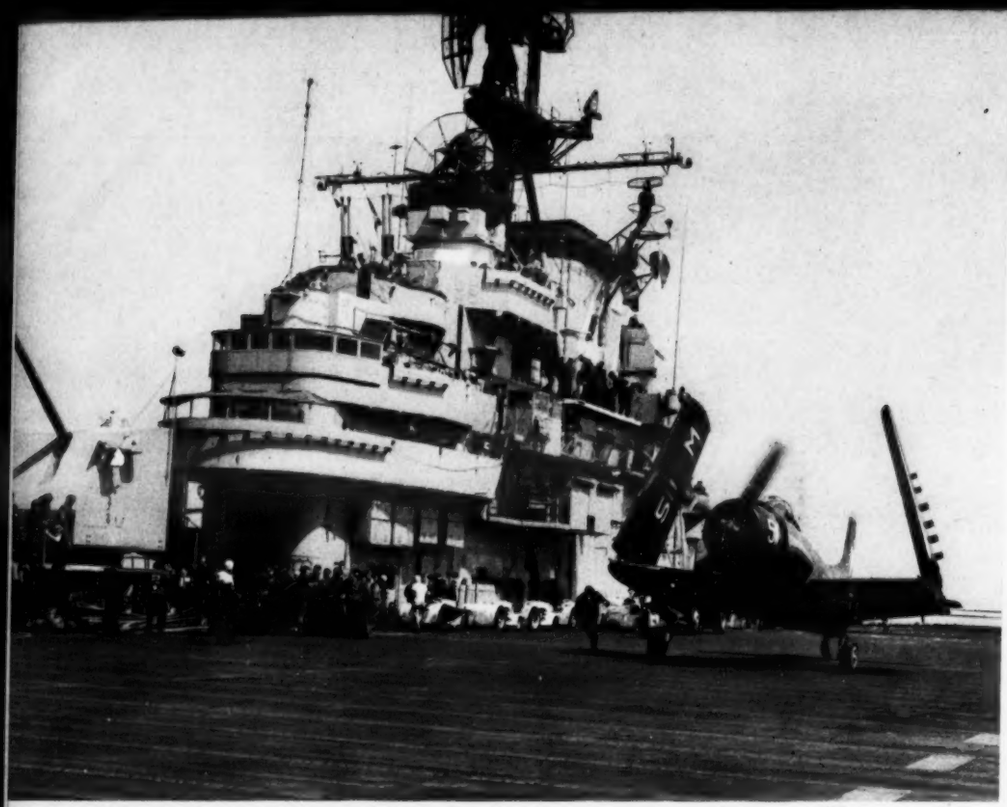
The *Forrestal*-class carrier represents very advanced thinking in the operation of fast naval combat aircraft. It is completely flush-decked, to avoid the hazard of collision with the "island" and its creation of turbulence over the flight deck. In addition to two parallel catapults along the forward deck, two canted deck portions are provided amidship each with launching catapults to permit the simultaneous launching of four aircraft and a reduction by half of the launching time required for a carrier air group. Additionally, their greater length, advanced equipment, vastly-increased breadth and myriad technical improvements will make them super carriers in every sense, despite the historical sensitivity of that word !

It is a commentary on the abiding confidence of the Navy Department that despite cancellation of the *United States* the plans and programs for aircraft construction originally intended for this giant vessel went forward. First product of the program was the North American AJ-1 *Savage* twin-engine carrier bomber, which was completed and placed in production. Four squadrons have now been outfitted and are serving aboard the *Midway*-class carriers. Photo-reconnaissance versions are now in production at North America's Columbus, Ohio plant and a turboprop version, the XA2J-1, is now undergoing evaluation trials.

The current crop of heavy jet fighters, including the Vought F7U-3, the McDonnell F3H-3 and the Grumman F10F-1, were specifically intended for the 60,000-ton carrier and these programs have continued without interruption. Already flying is the Douglas A3D twin-jet carrier bomber, which is in production in a rumoured large-scale program. Thus, these advanced aircraft will be ready in full air-group units to go aboard the *Forrestal*-class carriers upon commissioning, whereas had they been cancelled at the time of Johnson's precipitous action, the entire Navy carrier combat program would now be hopelessly behind schedule.

Former Navy Secretary Kimball confided in the Congress last year that he hoped, eventually, to *complete a program of ten such carriers*—eight of them with atomic power plant—which would give the U.S. a virtually invincible highspeed, huge carrier task force. However, there is no possibility of undertaking such long-range construction at this time and the Congress must be asked each year for funds for one, or possible two, additional carriers at a time.





Important in the readying of Pacific carriers for battle is modernization. Here is the island area of an Essex Class carrier as it appeared during World War II. Modernization will remove all guns from flight deck and reduce materially the size of the island.

The Aircraft Carrier

Ready to Sail!

Preparing U.S. Flattops for Combat

BY SCHOLER BANGS, LOS ANGELES

"A hell of a way to win a war!"

The Standard Gripe No. 1 of the United States armed services comes this time from a shivering, khaki-clad figure pounding the tent peg of a makeshift lean-to into the ground with a broken length of oak tree limb high up in a mountain canyon above the California desert. His back aches. His teeth chatter. His hands are dirty, face bearded, eyes watering from the stinging, sweet smudge from a smoldering camp fire. He is a U.S. Navy officer. He is getting ready to fly a jet fighter from his carrier some place, some day, probably off the ragged shoreline of North Korea.

Another jet pilot slides his aircraft into the canyon and eases down toward the informing paddles of his Landing Signal Officer; toward the "carrier deck" wind-littered with—tumbleweeds and sand. He's been doing this for weeks, the chalked outline of the Essex Class "deck" laid out on a desert flight strip a hundred miles and a mountain range from the nearest ocean water.

A thousand miles distant, up coast, their carrier lies; unbeautiful, disheveled, lashed dockside in a bay of Puget Sound's Bremerton Navy Yard. A crane lifts a big aluminum "can" that has been sealed over a gun mount since World War II. Grimy crewmen, unrated and untrained, who will sail her, give a hand with stripping endless sheets of protective plastic from hatches and doors, from rust-vulnerable equipment. The hull is a raucous bedlam of screeches and banging; of tear-out and replace.

Two thousand miles away, at the Naval Supply Depot in Johnsville, Pennsylvania, boxes of strangely new electronic gadgets get an inspector's final "O.K." stamp, and move toward waiting crates stenciled "Fragile."

Supply warehouses begin to feel the urgent pressure of orders for thousands of items of operating equipment and ship's stores.

Down coast at another port an ammunition depot is readied against the day the carrier will be warped in for her new guns, her massive load of bombs and rockets. On a distant desert Navy ammunition dump, perhaps at Hawthorne, Nevada, orders are received to begin trucking across the wasteland and through the mountains endless tons of assorted warheads.

Eventually all such disjointed activities will be brought together and into a sharp focus of purpose at a historically somnolent, semi-tropic seaport on the coast of Southern California.

Vice-Admiral H. H. Martin, commanding ComAirPac, who from headquarters at San Diego directs far-flung operations in getting carriers ready for combat.

Carrier pilots like this bit of Essex Class modernization —an escalator to carry them up from the ready room to the flight deck.

Ready to sail! In as short a time as seven months an Essex Class carrier such as this one may be removed from "mothball storage," reconditioned, outfitted with stores, modern equipment and personnel, and sent on her way out of San Diego Harbor for active duty in the Pacific. Photo shows carrier leaving dock at San Diego headquarters of ComAirPac, charged with operational readiness of flattops. San Diego is home port for all Pacific carriers.

At his headquarters on North Island Naval Air Station, the City of San Diego in the background across the bay, Vice-Admiral H. M. Martin gives a satisfied nod toward a carrier bristling with the upraised wings of planes crowding her flight deck like so many black butterflies basking in the sun. She's ready to sail!

Every aircraft carrier that goes out into the Pacific sails from San Diego, the aviation "corner store" of all Pacific fleets.

As ComAirPac, Commander Air Force U.S. Pacific Fleet, Admiral Martin and his staff of around seventy-five officers drag a used "market basket," a carrier hull, out of the corner, dust it out and clean it, fill it to the brim from store shelves throughout the United States, and put it on the counter at San Diego for pickup by their best, and only, customer, whose credit is excellent.

How long does it take to fill one of these "market baskets ?"

Admiral Martin's people say that in the space of six to eight months a carrier can be "de-mothballed," overhauled, filled with stores for an eight or nine months' tour of duty, manned, and sent sailing out of San Diego.

That is for the "standard job."

If Navy orders extras, say an *Essex*-Class $45,000,000 modernization, another seven months may have to be added before she is at the dock in San Diego and ready to sail.

An extra-super modernization, just recently developed and which cannot be detailed either as to cost or what it involves, will keep the carrier tied up in the yards for a full two years ! Undoubtedly this would include a complete re-decking with the new diagonal flight deck, drastic revision of hull interiors to handle multi-jet bombers, and re-arming of the carrier to handle anti-aircraft and long-range guided missiles for both defense and attack.

Suppose, however, that Task Force 77, operating off Korea, is in a hurry to get an additional *Essex*-Class flattop into action, and is willing to forego the $45,000,000 modernization. Here, roughly, is what will happen :

The moment the order is placed, and a given mothballed carrier in Navy Yard storage is tagged for restoration to duty, ComAirPac is in business.

Elements of her future operating personnel will begin trickling into the Yard to work with Yard forces in stripping off her plastic cocoon, break open sealed areas, clean engines and motors, recondition and replace if necessary her electric circuits and electronic gear.

Survival Training

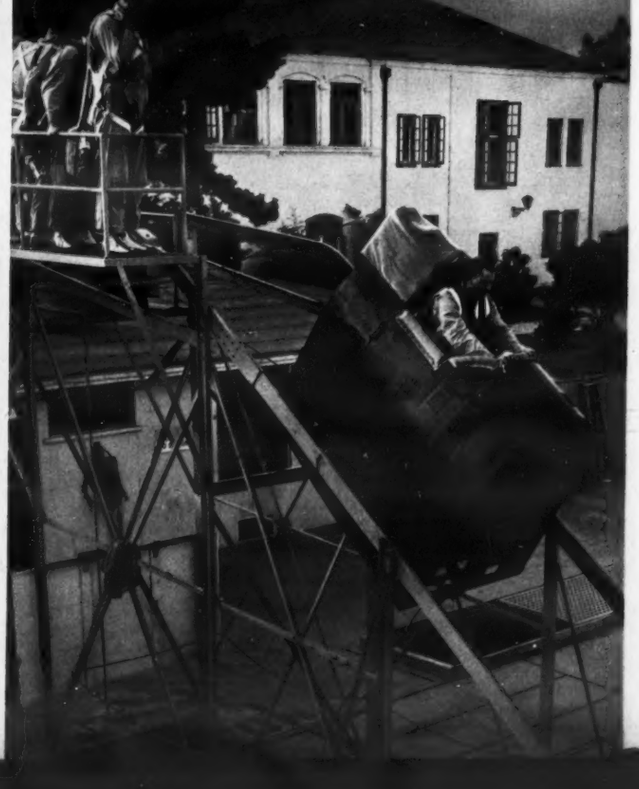
The lengths to which the Navy will go, during ComAirPac's readying of a carrier, in teaching air crews as well as other personnel "How To Stay Alive" mirrors the value placed upon the individual human in U.S. military operations.

Bail-out techniques, for various types of aircraft, and parachute control are basic in carrier air crew survival training. Dunking in shore station swimming pools, and escaping from model cockpits suddenly plunged upside down into the water, is extended at one stage to tossing air crews into the water fifteen miles off shore, where they must inflate their life rafts, board them, set up a radar corner reflector, and then "survive" until search planes locate and rescue them.

In all, ComAirPac puts air crew members through thirteen phases of survival training, including use of high altitude oxygen equipment, and instruction in the peculiarities of night vision. In darkened rooms they learn what to expect in the appearance of varied landscapes and cities under differing degrees of night illumination and under the sudden intense lighting of miniature flares. Training includes swimming through burning oil, helicopter rescue methods, and, for jet fighter and bomber crews, simulation of explosive ejection from a cockpit aboard an ejection seat trainer which hurls the crew member fourteen feet upward on a vertical track when he triggers the explosive charge beneath his seat.

Mattress softens the bump as pilot of piston-engine fighter leaves cockpit in a hurry in bail-out survival training at ComAirPac shore base. He'll do it over and over again until his technique is automatic and letter perfect.

Here a pilot is on his way to keep a date with a simulated ditching aboard a cockpit mock-up, nicknamed "Dilbert Dunker." Cockpit turns upside down in water to teach pilot correct cockpit escape procedure.



In preparation of carrier for combat, ship may visit a number of supply ports before ComAirPac finally declares her "Ready to Sail!" at San Diego. Here U.S.S. *Boxer* receives a fighter plane at Alameda Naval Air Station, California.

In thirty days—sixty, if there have been unforeseen delays which ComAirPac refers to as "slippage"—the bare ship should be out of drydock, afloat and under her own power.

At this stage the logistics planning of ComAirPac really goes into high gear. Still in the shipyard, the carrier is loaded with stores, spares and fuel. Then she is sailed to a selected ammunition depot port to get her guns and ammunition and be readied for her final cleanup toward spit-and-polish readiness for pre-delivery shakedown and training cruises.

While all this is going on, shipboard personnel not actually assigned to the carrier for de-mothballing and re-supply operations are being sent out on similar carriers to get the feel of the ship and train to perfection for the individual duties they soon will perform on "their" ship. It is a case of drill, drill, drill—and then drill some more to be ready for any cruising or battle emergency, fire, man overboard, collision, and all the bomb, torpedo and gunfire hits which might strike the ship in action. Each crew member must know letter-perfect the casual and emergency duties assigned to him on the Watch Stations and Quarters Bill prominently posted in his department; how to take over the duties of fellow crewmen at whom a drill inspector has pointed and said: "You're dead!" "Lie down here. You're wounded!" "You're blown overboard!"

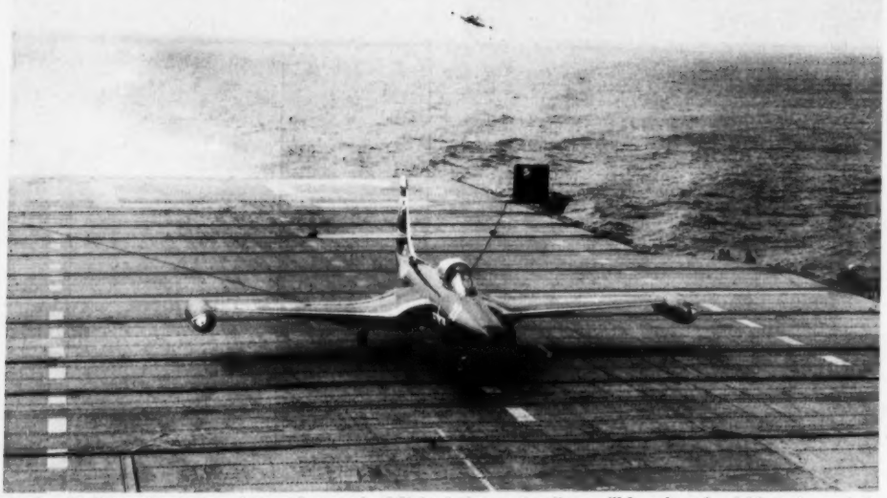
It is like that, too, with the air crews, who have begun to assemble and form up into squadron structures at air stations ashore for indoctrination and training while their carrier is being readied in the yards.

Pilots, gunners, navigators, bombardiers, plane captains and mechanics meet and receive their carrier station assignments, and then begin their own drill, drill, drill, and drill again toward the day when they'll begin to take on the resemblance of a "fighting team." The air crews will fly cross-country missions in the most miserable weather they can find; dream up fantastic emergencies; viciously bomb and rocket and machine-gun battered targets on sandy deserts, in mountain canyons, and off-shore target ranges. And endlessly the future carrier pilots will make precision carrier approaches just above the sagebrush, and, as dictated by the Landing Signal Officer who will be afloat with them and who quickly learns the landing idiosyncracy of each of "his" pilots, bounce the flight deck that floats on a sea of sand.

Airplane handlers and maintenance crews train for the day when they can ready a plane for combat flight in half an hour instead of the twelve hours it may have taken them at first. Plane captains practise with every training flight their split-second flight deck job of buckling their pilots into their seats just before takeoff; meeting their pilots at the end of the flight to receive air crew "gripes" and instructions for reconditioning the plane for the next mission. The plane captain is the only below-deck squadron member who, aside from air crews, is authorized to join flight deck personnel during air action. And, his job is not envied. Carrier veterans hold that in combat the flight deck strictly is "for the birds," and that anyone who is up there if he doesn't have to be is "simply off his rocker."

It is during this time, an interlude in their combat training flight missions, that the carrier's future air crews find themselves suddenly foraging in a bleak mountain wilderness, or being unmercifully "dunked," wearing full flight gear, in a salt water swimming pool.

Bristling with her complement of Douglas "Skyraiders," Vought "Corsairs" and McDonnell "Banshees," the U.S.S. *Essex*, readied for duty by ComAirPac, is turned by tugs to sail from San Diego Harbor. City of San Diego is seen dimly in background.



Banshee jet fighter has just made a perfect catch of flight deck arresting line ; will be released quickly to leave deck clear and ready for next plane seen swinging into « groove » in distance. Unseen in photo, and still under security classification, is new type of emergency barrier which catches jets by their wings with little or no damage.

It is all a part of air crew survival training against a day when they might be forced to bail out over enemy mountains, or crash land a crippled plane in the ocean. And, it pays off ! The proof is in the stories of downed Navy pilots who have made their way out of the mountains of Korea ; pilots who have extricated themselves from their harness and cockpit impediments and bobbed to the surface within seconds after their planes have crash-landed in the water and started sinking.

"What we're trying to do in all this," a ComAirPac spokesman re-emphasized, "is to get every member of the ship's personnel, some three thousand officers and men aboard an Essex Class carrier, trained to the point that by the time he goes aboard he'll be as fit as the ship he sails, and ready to act automatically in any emergency."

ComAirPac officers indicate that personnel fitness is without question a major item in their outfitting of Pacific carriers.

Even after the carrier finally has arrived at San Diego to receive, from other ships and from shore stations, the personnel who are to man her throughout her tour of duty, the drilling continues throughout numerous, fairly brief, training cruises off shore. Pilots of her hundred planes may complete on her deck the twenty carrier landings required before they, finally, are "ready to sail."

Once ComAirPac has delivered its "market basket," and the carrier is on her way to Pearl Harbor, the same old drills are repeated over and over again. What normally might be a five days' cruise to the Hawaiians may stretch into seven as a result of "polishing off" maneuvers, emergency drills and training flights.

It will happen again at Honolulu, too ! The carrier will sail out from Pearl Harbor on a two days Operational Readiness Inspection conducted by tough, remorseless examining teams of CINCPAC (Commander in Chief, Pacific). Again the drills, the dreamed up emergencies, and finally, in a scorching wardroom critique, an evaluation of just how well, in personnel, ComAirPac has filled the basket. One by one, CINCPAC's inspection board will inform the commanders of the carrier's nine departments—operations, supply, engineering, gunnery, air, medical, dental, administration, and air group—their mistakes ; infrequently will give a department commander a "Well done !" Department commanders who have been scorched may be expected, without any notable delay, to stage their own departmental critiques with their crew chiefs. And then, progressively, the chiefs will take it out on their unrated personnel, the "Indians."

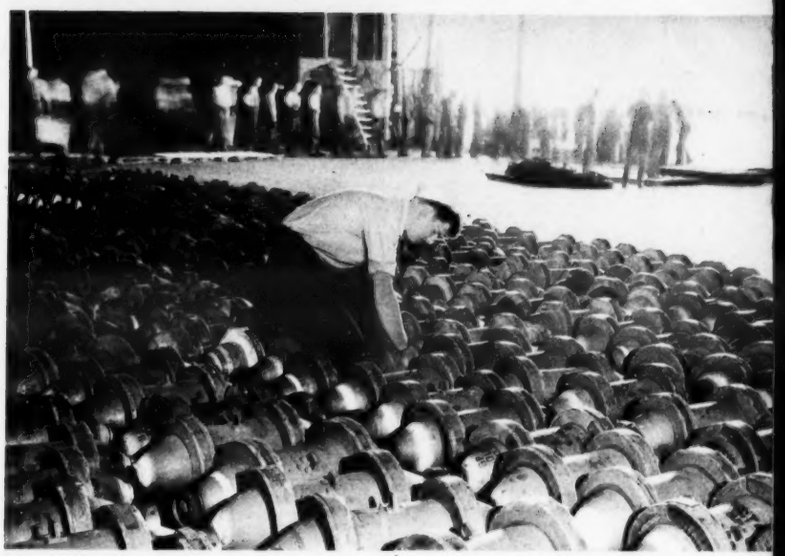
For all practical purposes, however, ComAirPac's job is done, for the time being, when the carrier is nudged about in San Diego Harbor and headed seaward toward the Hawaiians. Eight or nine months may pass before the particular flattop slides into San Diego again, and ComAirPac takes over once more for a turn-around refurnishing and repair of the ship which may take from three to seven months.

Specifically, how big a chore this is for ComAirPac—initially outfitting for combat carriers long in mothballs, and re-outfitting them

Survival training is part of ComAirPac's preparation of a carrier for combat. Here an air crew roughs it in California forest, learning how to stay alive if forced down in enemy mountains.

Complete training of air crews as a team is part of ComAirPac's preparation of a carrier for combat duty. Here is typical scene of pilots in "de-briefing" room after completion of a mission.

ComAirPac counts plane captain a key man in organizing air crews for carrier being readied for combat. He is the last to check pilot's gear in cockpit before takeoff; first to meet pilot on flight deck after he returns from mission.



Freshly out of her shipyard, the carrier being readied for combat will sail to a Pacific Coast ammunition depot to receive new guns and ammunition including 100-lb. bombs such as are shown here.

between their tours of duty—cannot be disclosed for security reasons.

Military security prevents definition of the number of Essex class carriers in the Pacific which have been given, or are receiving, the elaborate "Essex Class Modernization." ComAirPac is able, however, to reveal in general terms the improvements that go into these ships during such modernization.

New blisters are added to each side of the hull for increased protection and stability. The flight deck is reinforced to handle heavier planes. Flight deck guns are removed and placed in open gun tubs alongside the ship and below the flight deck.

The island structure is re-designed and streamlined; made smaller, with many of its interior spaces relocated for greater efficiency. A new type of barricade, which stops jet fighters by their wings and reduces the risk of plane damage and pilot injury, replaces old-type crash barriers. New-design deck catapults are installed, capable of handling heavy jets and push-button operated from the flight deck. All three airplane elevators are improved to carry heavier loads, and the capacity of the deck edge elevator is doubled. Hangar deck changes include installation of new electrically operated doors which can isolate and seal off sections of the hangar deck in a matter of seconds. This change is said to have reduced tremendously the risk of a small hangar deck fire spreading through the whole storage area. The risk is lessened still more by installation of fog-foam fighting equipment capable of pouring upon a blaze area several hundred gallons per second of the fire smothering mixture.

Ammunition handlers train in the arming of rockets with warheads, seen on deck, for their duties aboard flattop being readied for combat duty.

ComAirPac's reference to the replacement of hundreds of miles of ship's wiring in the Essex modernization indicates the installation of a considerable quantity of new electric devices as well as replacement of old ones.

A seemingly luxury frill of the modernization is the installation of escalators to carry pilots and other air crew personnel from the ready room up to the flight deck. Yet, in Navy eyes, this is a strictly utilitarian addition to forestall a crew member's becoming sweaty in climbing to the flight deck. Experience had shown that perspiration-soaked clothing not only could be uncomfortable at high altitude, but might even be a definite hazard in a ditching in icy water. The crew member might freeze to death in his own sweat before he could be rescued!

Supplying a carrier may continue at sea, and here a crated wing panel is being swung out from U.S.S. *Jupiter*, aviation supply ship.

Maintenance as Safety Factor

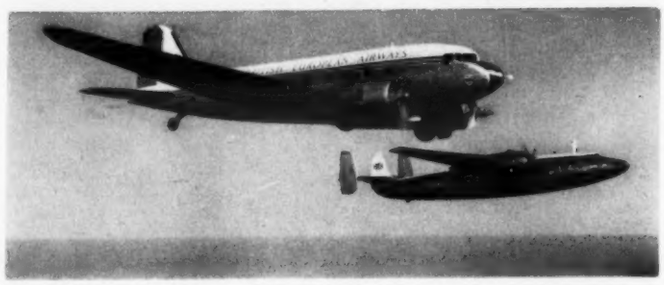
BY B. S. SHENSTONE, LONDON, CHIEF ENGINEER, BRITISH EUROPEAN AIRWAYS CORPORATION

BEA includes overhaul in the term "Maintenance" because it is similar work done by similar people. Even at minor checks some equipment is removed for overhaul. Maintenance is essentially by replacement, so that any work beyond inspection must imply some sort of overhaul, but not necessarily on the aircraft. Some operators limit base operations to major overhauls, say at 1,000-hour intervals, whereas others do minor maintenance at base.

To what extent line or minor maintenance is done away from base depends more on geography than policy. An airline with a star-shaped route pattern can afford to bring aircraft into base more often than one with a linear pattern, particularly when the latter has local self-contained operations. Again, when distances are long and the route density is low, more work must be done away from base.

The main requirement for a base is that it should be on the routes and at a station where there are many movements. Apart from this, the location will be decided by nearness to supplies and labour market—in fact the decisive factors in setting up any factory. The word "factory" is used advisedly, for aircraft maintenance and overhaul is a repetition job suitable for the application of modern production methods, including incentives.

Once this right attitude of mind—that the problem is production—has been developed, the rest follows fairly easily. The aircraft must be fed into base on a firm schedule. This schedule must be controlled by the maintenance staff. There must be proper production planning and production control to enable the right work to be done at the right time. There should be an incentive scheme based not upon generalized performance such as ton-miles per month but on individual jobs in the shops. The kind of work to be done should be worked out and balanced so that, in addition to fulfilling airworthiness requirements, it fits the shop techniques and planning. There should be a programme of development linking the shops and the development branch, one complementing the other so that improvements can be phased properly. There should be a workable modification scheme. There should be well-planned tools and jigs including overhaul docks. Most airlines have some of these features in highly developed forms. No airline has all of them.



The Vickers "Viking" (Pionair Class) and Airspeed "Ambassador" (Elizabethan Class), British European Airways' "work horses."

Production control, which has been mentioned, is worthy of a few special remarks. Its importance to maintenance is great, for it is obvious that the best planning in the world would be of little use if there were no control on the way the work already planned is loaded on the shops. This is the primary duty of Production Control and it is essential that they ensure that the Stores position is maintained at the right level, while the loading on each particular shop meets the weekly consumption programme without subjecting the shop personnel to continual and irregular outbursts of overtime, or, on the other hand, long periods of inactivity which are expensive as well as demoralizing to the staff. In view of this duty, Production Control are in the best position to advise the Supplies Branch on all purchasing problems ; therefore, it is they who place the orders on the Supplies Branch.

The overhaul can be done either by the airline or can be contracted out, depending on local circumstances. BEA has tried, and is still trying, both methods. The feeling of the author at present tends more towards the airline doing the overhauls, but this is not a ruling for BEA. It has often been said that the best man to do the overhaul is the manufacturer, who necessarily knows the equipment inside out, and that the best man to do the overhaul is a big man who does a lot of overhauls and therefore has well-equipped shops. Both these generalizations are false. Some makers have special overhaul factories which are never seen by the manufacturing and design departments. There is sometimes a lack of collaboration between overhaul facilities and design staffs, so that typical design errors are repeated. The big overhauler likes a straight run and is not anxious to do the special little things a particular airline may want.

An airline, even a big one, is small enough for its aircraft to have personality and hence a personal history. To a less degree the same is true of equipment. The same pieces pass through the shops again and again.

It is easier to control a limited recurring group of equipment than to deal with a mass of things from different sources, particularly if the overhaul shops are run by the man responsible for getting the aircraft on service and have direct access to the development group to enable a constant interchange on development and techniques. In no other kind of shop will the drive towards improvement be as great.

Aerial view of BEA's maintenance base at Northolt Airport, London.

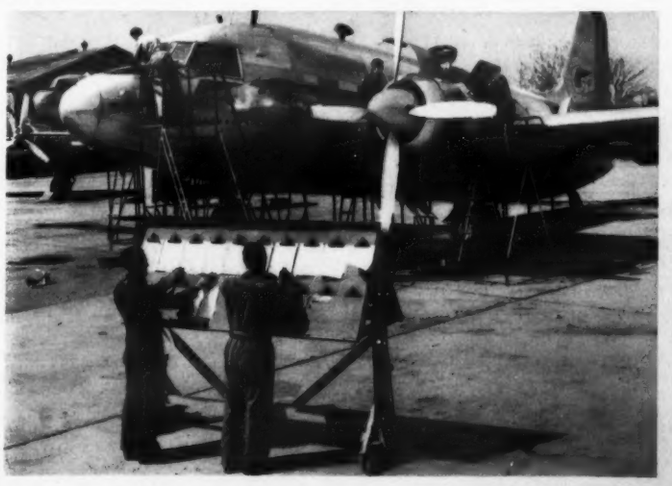
It must be appreciated that the incorporation and maintaining of modifications standards is one of the biggest difficulties for maintenance personnel. Unlike a production factory, which has only to make the modification on the actual aircraft or component passing through the shops at the particular time at which the modification is found necessary, an airline has to maintain for long periods its aircraft and components, continually checking that all modifications are incorporated, while at the same time adding later modifications. It will be obvious that if some definite system is not laid down a modified aircraft, by virtue of a component or unit change, could become an unmodified aircraft.

To overcome this, BEA has instituted its modifications breakdown. All modifications, as they are issued, are broken down into the workshops which handle the various components or units affected, and these shops are then told which modification affects their particular sphere of duty. With this method, any unit requiring overhaul is checked against the modifications breakdown and brought up to standard if necessary, thus avoiding reliance on the individual's memory or the necessity of wading through the complete modification book on every overhaul. In addition, a complete set of modifications breakdown is passed to Stores, who check all incoming goods against the sections of the breakdown applicable to the particular component being considered. It is then immediately evident, by reference to the documents accompanying the component or unit, when it is necessary to make any further modification before issuing to the base concerned.

Experience has also taught BEA that civil aviation changes so quickly that any layout chosen for a base must be inherently flexible.

An "Elizabethan" (Airspeed "Ambassador") leaving BEA's new maintenance shops at London Airport.

Results of the overall check of a "Pionair" (Vickers "Viking") are marked on progress sheets.



Overhauling and checking aircraft instruments at Northolt.

For its new base now being built at London Airport the hangar space is built up of a duplication of a shallow hangar with a door on one long side. The dimensions of this basic unit were worked out in an effort to foresee what the next twenty years have in store for the short-haul airline. BEA chose a clear door width of 150 ft., a clear height (below overhead crane) of 30 ft. and a clear depth of 110 ft. One hundred and ten feet should be long enough for any short-haul aircraft for a long time. The hangar is shallow so there will be no temptation to try to get more than one aircraft into a bay at a time.

Five such bays are joined together, making a unit 900 ft. long (including the width of the columns at each bay). The whole unobstructed length and width is covered by a five-ton overhead crane. Behind the five hangars are shops 80 ft. wide and behind the shops is an access road. Beyond that again the whole thing is duplicated ; that is, there are a further five hangars and shops, mirror images of the first. At one end the two blocks are joined by a building housing some stores and certain shops. The result is a compact base which is inherently cheap per square foot of floor.

The capacity of this base is not yet known because the check periods of the new airliners to be stationed there are unknown, but the capacity may be of the order of 300,000 flying hours per year. This assumes that about half the hangar area will be used for minor maintenance work.

Maintenance schedules have to be designed to meet the high standard laid down by BEA from the safety point of view, as well as to meet the round-the-clock operation of the aircraft, bearing in mind the fact that at few locations only very minor maintenance checks are made. Thus the maintenance schedule itself is not purely an inspection document designed only to cover the necessary maintenance work, but must be capable of adaptability to the type of operation foreseen for the aircraft for which it is designed.

BEA has never scheduled a complete overhaul at some high figure such as 10,000 hours. All the overhauls necessary are done in four cycles of the basic figure, which in 1951 stood at 1,000 hours for Vickers Vikings and 800 hours for DC-3s.

BEA has been striving to get the engine life the same as the major check period, because both Vikings and DC-3 engine changes are slow jobs and cause much disturbance of routine when they occur at minor checks. With new aircraft having quick-change power plants this coincidence will lose importance.

Press Mosaic

✱ "Daily Telegraph," January 22nd, 1953: "Inside information"

"A certain amount of jocular comment has been caused among fliers, I hear, by the recent goodwill tour of four Canberra bombers in South America.

"At the moment only Service personnel on duty and civilians engaged in building or testing these aircraft are allowed inside them. This rule has been broken for only a very few people, such as the Secretary for Air.

"During the South American trip, however, a substantial number of junior officers in Latin-American air forces were taken up for flights. Another passenger, I am told, was Kurt Tank, the eminent German aircraft designer who went to the Argentine after the war..."

✱ "Time," January 12th, 1953: International/NATO, "23 Days to Paris"

"NATO's champion fire-eater is Marshal Juin of France, commander of its Central European ground forces and one of the Allies' sharpest World War II fighting men. Last week, addressing reserve officers at Strasbourg, this field-soldier son of a policeman offered a chilling counterblast to Europe's growing complacency :

"The enemy has installed himself in Saxony and in the Thuringian salient, 150 kilometers from the Rhine. This salient is, in the heart of Germany and toward the heart of France, a . . . loaded pistol.

"If one transplants to the Rhine region that offensive maneuver developed by the Russians in White Russia against the Germans in 1944, and grants them (the Russians) the same concentration of forces and rhythm of advance, such an attack . . . would be capable of reaching Paris in 23 days."

✱ "Der Spiegel," January 7th, 1953: "European defence—by hedgehog positions"

". . . The hedgehog position forms the basis of both Gruenther's and Harding's plans. Chester Wilmot, the British Staff's blue-eyed boy among military writers, recently described it thus : in the event of a Russian attack, NATO units would form hedgehogs similar to those formed by the Germans in Russia. The hedgehogs in the interior would be supplied by air, and those on the coast from the sea. The hedgehogs would be surrounded by what Wilmot describes as 'deep belts of destruction'. Long-range artillery would protect them from enemy attacks.

"The object of these 'strategic islands' is to enable one's own units to make outflanking movements in the enemy's rear and to 'channel' the enemy's operations into certain areas, so as to blunt his attack, split up his forces and —as a long-term measure—cover the Atlantic hinterland, which is required for building up a major counter-offensive, for as long as possible."

✱ "Time," January 19th, 1953 : "The Hemisphere—Canada" : "New Front Door"

"In the postwar air age, Gander Airport in northeastern Newfoundland has replaced the seaport of Halifax as Canada's front door. More than 300,000 transatlantic air travelers landed there in 1952 ; many get their first and only impression of Canada at the field. Gander's 8,600-ft. main runway, its instrument-landing equipment, and the high-intensity runway lights now being installed make it technically one of the world's most up-to-date airports. But in the creature comforts by which most tourists form their opinions of a port of call, Gander Airport is as outmoded as a whaling ship.

"Arriving at Gander, passengers are herded off their planes through long, wooden ramps appropriately called 'sheep runs'. The ramps lead to a vast, gloomy hangar built in 1941, when Gander was expanded to serve as a bomber ferry base. Grounded travelers, hung up in Gander for periods varying from an hour to two for refueling to several days for bad weather, have little choice but to haunt the airport's brawling, barnlike waiting room in a bedlam of children's cries and squawking announcements by 20-odd airlines. Grand Falls (pop. 16,059), the nearest town of any size, is three hours away by slow train. Three-day-old newspapers, and long, morose drinks of potent Newfoundland 'screech' (rum) at the crowded bar* are the chief available diversions from the monotony of staring at the cheerless landscape.

"Realizing that Gander's grim aspect is the worst kind of advertising for Canada's tourist trade, the Department of Transport recently flew a group of government officials into Gander to see what could be done about improving the place. Last week some of the experts' proposed changes began to take shape. A new catering firm was signed up to improve the dining service. Architects went to work on plans to brighten the interior of the hangar waiting room, to tear down the sheep runs and replace them with paved walks. The raucous confusion of airline announcements will be replaced by a single announcer system ; newscasts and soothing music will be piped into the waiting room.

"Workmen already have converted a section of the hangar into a small but comfortable movie theater. The National Film Board is supplying the theater with documentaries about Canada's modern cities and its showier tourist places (e.g., Banff, Lake Louise, Niagara Falls), all frankly calculated to reassure travelers that the inside of Canada's house is not so forbidding as its bleak front porch."

* The only bar in Canada open 24 hours a day.

✱ "Daily Mail," January 22nd, 1953 : "Incidental intelligence"

"A report just presented before the French Academy of Sciences reveals that radar waves cause cats to develop a nervous cough."

✱ "Die Zeit," January 15th, 1953 : "Japan plans air fleet"

"A plan for a Japanese air defence force has been submitted to the Japanese National Security Authority by a group of former Japanese Air Force officers led by Admirals Hoshino and Yamamoto. The plan envisages two phases of three years each. The first phase calls for the provision of 800 front-line and 400 reserve aircraft, to cost a total of 210,000,000 yen—one third of the annual Japanese defence budget. In the second phase aircraft strength would be increased to 3,000. The officers claim that the United States Far East Air Force is in favour of these plans."

✱ "Die Welt," January 21st, 1953 : "The unfinished house—the Basic Law a provisional document."—By Dr. Oswald Göbel

Editors' note : The ratification of the Paris agreement on the European Defence Community is meeting with considerable difficulties in the West German Parliament, the Opposition objecting that the so-called "Basic Law," i.e. the constitution of the West German Federal Republic, forbids the formation of armed forces. In order to be able to rearm the constitution must first be changed, which needs a two-thirds majority. It is interesting, however, to see that weighty arguments can be brought up for the other side, as the following lines show.

"The Basic Law unquestionably contains no provision regulating defence sovereignty. If this silence were to be interpreted as a conscious condemnation of defence sovereignty, it would follow inevitably that the European Defence Community treaty would make an amendment of the Basic Law essential.

"However the unbiassed reader of the Basic Law will realize that it contains neither positive nor negative decisions on the question of defence sovereignty, but ignores the subject altogether. No wonder. Before the Basic Law could be ratified by the West German Länder, it had to be submitted to the Military Governors of the three Western Occupation Zones. At that time their veto of any provisions relating to armed forces would have been as certain as Amen in church."

Braking the Landing Run of Jet Aircraft by Thrust Deviation

By K. ISERLAND, Dipl. Ing., Division of Aerodynamics, Federal Institute of Technology, Zürich

Summary: The first part of this article compares the landing runs of aircraft slowed down with wheel brakes alone, with wheel brakes plus brake parachute, and with brake thrust plus wheel brakes. It is disclosed that the brake parachute is sufficient substantially to shorten the landing run, but only with high initial deceleration. Thrust braking is found to be superior in braking effect to the parachute, at the same time involving much lower initial deceleration. Considerable advantages are offered by thrust braking in the case of ice-covered runways.

The second part contains a review of the experiments conducted by the Aerodynamics Division of the Swiss Federal Institute of Technology with a view to developing a thrust braking device. Although initially carried out in the incompressible range, they indicate the possibility, without detriment to the functioning of the engine, of deviating a jet by the use of rotation and retractable annular deviators. Braking thrusts in the order of 60 % of the static thrust have been achieved.[1]

I.

It is well known that it is increasingly difficult to cope with the growing take-off and landing distances resulting from ever increasing flying speeds of modern aircraft merely by lengthening the runways. A solution must be found in which take-off and landing runs are shortened in spite of fast flying speeds. Methods of increasing the wing's maximum lift coefficient encounter serious difficulties owing to the high-speed characteristics that are required.

One possible key to the problem is to increase the thrust of the power plant for take-off and the braking power for the landing run. While the former is a practical reality today in the shape of ever more powerful engines, afterburners and take-off rockets, efforts to augment the braking power of the wheel brakes alone are hampered by limitations of the maximum brake size and the wear or the melting point of aircraft tires.

Thus, it is necessary to consider novel methods of braking. In the case of propeller-driven aircraft it was the reversible-pitch propeller that provided the solution. For jet aircraft two principles offer a possible way out :—

a) use of aerodynamic drag through retractable air brakes on wings or fuselage or through a braking parachute ;

b) braking by jet thrust acting in the direction of flight either with braking rockets or reversing the jet engines' thrust.

In the military field the brake parachute has already been adopted to a certain extent and belongs to the standard equipment of several aircraft types.

[1] The contents of this article were the subject of a paper read by the author on 3rd December, 1952, before the Federal Advisory Committee for Aeronautics at the Federal Institute of Technology in Zürich.

The use of thrust reversal was first mentioned only recently when it was learned that S.N.E.C.M.A. (France) was experimenting with a thrust deviator (" Aviation Week ", 22nd December 1952). No details of the device have been disclosed.[2] The Aerodynamics Division of the Federal Institute of Technology has been conducting experiments along these lines for over a year, and these will be described in the second part of this article.

To begin with, it may be interesting to examine the results which theoretically can be achieved with the different braking methods. In the following paragraphs the landing runs are calculated and compared for the various types of brake.

Through integration of the dynamical equation one obtains for the landing distance s from the beginning to the end of the braking process (i.e. from speed V_a at touchdown to speed V_e equivalent to taxiing speed) the following formula :

$$s = s_a \cdot ln \frac{1 + \frac{b_k}{b_{a_L}}}{\frac{V_e^2}{V_a^2} + \frac{b_k}{b_{a_L}}}$$

$$\text{or for} \quad V_e = 0 \; ; \; s = s_a \cdot ln \left(1 + \frac{b_{a_L}}{b_k}\right)$$

where

$$s_a = \tfrac{1}{2} \cdot \frac{V_a^2}{b_{a_L}} = \frac{1}{\gamma} \cdot \left(\frac{G}{F}\right)_L \cdot \frac{1}{c^*_w}$$

$$b_{a_L} = g \cdot \frac{c^*_w}{c_{a_I}} \; ; \; b_k = g \, (\mu + x \cdot \sigma_L)$$

$$c^*_w = c_{w_R} + \frac{F_{FS}}{F} \cdot c_{w_{FS}} - \mu \cdot c_{a_R}$$

In this formula :

γ = Specific weight of the air

$\left(\frac{G}{F}\right)_L$ = Aircraft wing loading at landing

g = Acceleration due to gravity

μ = mean braking coefficient of wheel brakes (braking force / aircraft weight)

σ_L = $\frac{S}{G_L}$ (S = engine static thrust ; G_L = landing weight of aircraft)

x = $+ \lambda$ in the case of thrust braking (λ = ratio of brake thrust to static thrust)

x = $- \delta$ in the other cases (δ = ratio of idling thrust to static thrust)

c_{w_R} = aerodynamic drag coefficient of aircraft during the ground run

[2] Prior to 1946 a thrust deviation device was developed in England by *Power Jets, Ltd.*, to facilitate the landing of jet aircraft aboard aircraft carriers. It was intended less for braking purposes (it produced a braking thrust of less than 12% of the normal thrust) than to eliminate the thrust to enable the engine to continue to run at full r.p.m. (thus providing the possibility of quick starts after baulked landings). However, it never became standard equipment of any type.

c_{a_R} = lift coefficient of aircraft during the ground run

c_{a_L} = lift coefficient of aircraft when landing

$c_{w_{FS}}$ = parachute drag coefficient

F_{FS} = parachute frontal area

F = aircraft wing surface

b_{a_L} is the deceleration produced by aerodynamic drag forces at the beginning of the braking process (at speed V_a), minus the decrease in wheel braking force as a result of the residual lift.

b_k = represents the deceleration resulting from the forces (assumed to be constant) of jet and wheel brakes (the latter without decrease through residual lift), taking into account the idling thrust.

The total deceleration at the beginning of the braking process is represented by—

$$b_{a_l} = b_{a_L} + b_k$$

It is the maximum deceleration occurring with parachute braking ; in the case of jet thrust and wheel braking the maximum deceleration is only 0.025 g greater than the initial deceleration in the cases considered.

For purposes of comparison, Fig. 1 to 3 show the landing distances needed for braking down to zero speed with—

a) Wheel braking alone
b) Parachute plus wheel braking
c) Jet thrust plus wheel braking

calculated for landing wing loadings $(G/F)_L$ = 175 ; 200 ; 225 and 250 kg per square metre and an airfield altitude of 500 m above sea level (this produces landing speeds of 48.5, 50.9, 53.8, and 56.8 m per second at $c_{a_L} = 1.3$) with the following assumptions:—

$c_{a_L} = 1.3$; $c_{a_R} = 0.5$; $c_{w_R} = 0.1$; $\delta = 0.08$;

$\sigma_L = 0.5$ (with jet thrust braking also $\sigma_L = 0.25$)

In order to gauge the strain on the aircraft occupants, the initial deceleration with reference to the acceleration due to gravity is also indicated.

a) Wheel brakes alone

The landing run distances s are plotted (Fig. 1) against the mean wheel braking coefficient (braking force/aircraft weight). Braking with $\mu = 0.35$ already corresponds to an emergency braking which a tire will withstand only once and in practice represents the limit of what is possible. However, for comparison with the other braking methods, the curves are plotted up to $\mu = 0.8$.

By very heavy braking with $\mu = 0.3$, one obtains landing runs of 480 to 690 m ; with $\mu = 0.25$ (a high value for normal braking)

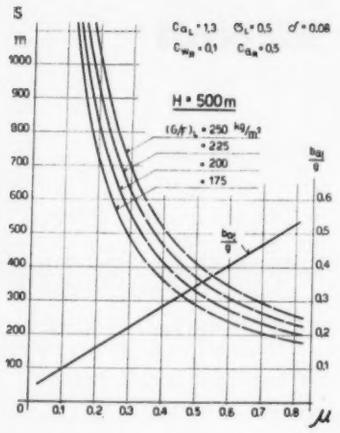


Fig. 1. — Landing run and initial deceleration with wheel brakes.

of 570 to 820 m. Initial decelerations are low: 0.22 g for $\mu = 0.3$ and 0.19 g for $\mu = 0.25$.

b) Brake parachute plus wheel brakes

The landing runs are given as a function of the parachute area (in relation to the aircraft's wing area). Here again the right-hand side of the curves must be regarded as more or less Utopian as it corresponds to very large parachutes which are not in use today. Current brake parachutes have a frontal area about one-third of the wing area (example: Boeing B-47 "Stratojet" bomber).

This size of parachute produces, with the additional use of wheel brakes at $\mu = 0.25$, landing runs of 370 to 530 m. This corresponds to $\mu = 0.38$, i.e. to an increase in mean braking force of about 50 %. The initial deceleration is 0.45 g (quite apart from the parachute opening shock), compared with 0.27 g for $\mu = 0.38$ with wheel brakes alone.

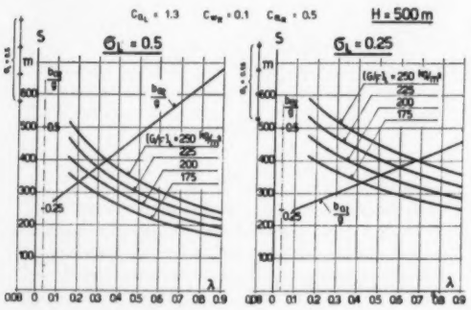


Fig. 3. — Landing run and initial deceleration with jet thrust braking and wheel brakes.

This shows up a disadvantage of parachute braking: for identical landing run distances one must put up with much greater initial deceleration than with the use of a constant braking force, since the parachute braking force diminishes as the square of the forward speed. This is significant especially when extremely large parachutes are employed. Thus for a parachute of $F_{FS}/F = 1.3$ (at $c_{a_L} = 1.3$ this corresponds to a deceleration of 1 g through the parachute alone, without the opening shock), together with the effect of wheel braking, idling thrust and aircraft drag, the initial deceleration would be 1.2 g which, on the other hand, would result in landing runs of 205 to 290 m. This would correspond to wheel braking at $\mu = 0.7$, which is far beyond the limits of possibility.

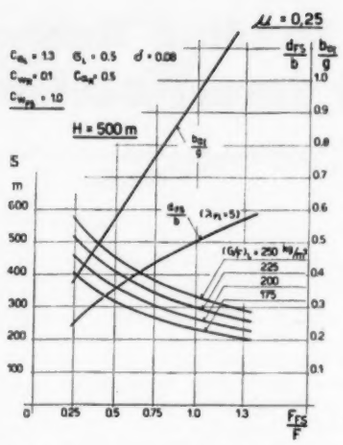


Fig. 2. — Landing run, initial deceleration and parachute size for parachute braking plus wheel braking.

In order to give an idea of the parachute size to be used, Fig. 2 also shows the ratio of the parachute diameter d_{FS} to wing span b for an aspect ratio $\lambda_{Fl} = 5$.

c) Thrust braking plus wheel brakes

Fig. 3 shows the landing runs attainable with thrust braking, i.e., through the deviation of the engine jet. Here λ is the ratio of the braking thrust of the deviated jet stream to the static thrust of the engine.

The diagram on the left illustrates the conditions of an aircraft with relatively high thrust ratio [3] ($\sigma_L = 0.5$), the diagram on the right applies to less powerful aircraft ($\sigma_L = 0.25$ roughly corresponds to the landing of a "Comet 1" after using half its fuel). Wheel braking at $\mu = 0.25$ is again used.

For $\sigma_L = 0.5$ even a relatively slight jet deviation of $\lambda = 0.3$ gives landing runs of 295 m to 420 m. As will be shown in the second part of this article, however, braking thrusts of about 60% of the static thrust, or $\lambda = 0.6$, can be expected, so that landing runs of 215 m to 305 m could be reached.

[3] Reciprocal value of thrust loading.

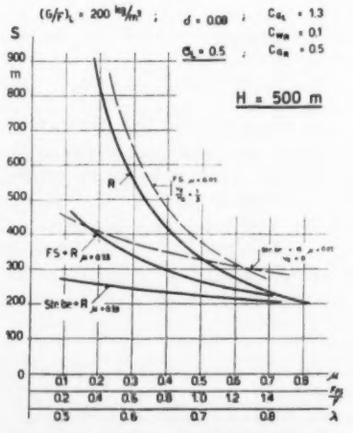


Fig. 4. — Comparison of landing runs attainable with wheel, parachute and thrust braking.

This would be equal to wheel braking at a value of 0.68 for μ—which is not feasible—and would correspond to the effect of an extremely large parachute, as just mentioned ($F_{FS}/F = 1.3$). Initial deceleration, however, is only 0.53 g, i.e., less than half of that encountered in equivalent parachute braking.

Even the lower-powered aircraft of $\sigma_L = 0.25$ will have very good landing runs: 295 m to 420 m at $\lambda = 0.6$ (this would correspond to $\mu = 0.45$) with an initial deceleration of 0.38 g.

Comparison of braking methods

In Fig. 4, the landing runs attainable with the three braking methods under consideration for $(G/F)_L = 200$ kg/m² are once again plotted against the corresponding parameters. As previously stated, the region of $\mu > 0.35$ is beyond the scope of wheel braking and hardly within that of parachute braking with $F_{FS}/F > 0.4$. For thrust braking the value of $\lambda = 0.6$ can be regarded as practicable.

It is clear that the use of a brake parachute produces an obvious advantage over pure wheel braking, and that thrust braking in turn is superior to parachute braking. As regards the aircraft occupants, thrust braking is greatly superior owing to its lower initial deceleration. While parachute braking will probably remain limited to military use, thrust braking appears suitable also for civil application.

The broken curves in Fig. 4 indicate the conditions occurring in the event of wheel brake failure or complete icing of the runway. In these cases, only the rolling friction ($\mu = 0.02$) will act on the wheels. Owing to the idling thrust it will then be impossible to reach zero speed without thrust braking. The asymptotically attainable speed will then be:

$$V_e = V_a \sqrt{\frac{b_k}{b a_L}} \quad \text{(at } s = \infty\text{)}$$

For to-day's parachutes this is about ¼ of the landing speed. For comparison, the landing runs with thrust braking down to $V_e = 0$ and parachute braking to $V_e = 1/3 \cdot V_a$ are indicated. Unlike other braking methods, thrust braking in these cases is still fully effective. It will make possible braking to a standstill over a distance of 375 m (at $\lambda = 0.6$). This would be equivalent to wheel braking at $\mu = 0.44$, i.e., a slowing down process not possible with wheel brakes on a dry concrete runway even by completely wearing out the tires!

II.

In view of the considerable advantages of jet thrust braking, work has been carried out at the Division of Aerodynamics of the Federal Institute of Technology to study the feasibility of deviating the jet stream.

The following requirements were formulated for the deviator:

1. Maximum degree of jet deviation (maximum braking power)
2. Rapid change-over from jet deviation to normal jet thrust position (in the event of baulked landings)
3. Low repercussion on pressure ahead of the jet pipe (small effect on engine)

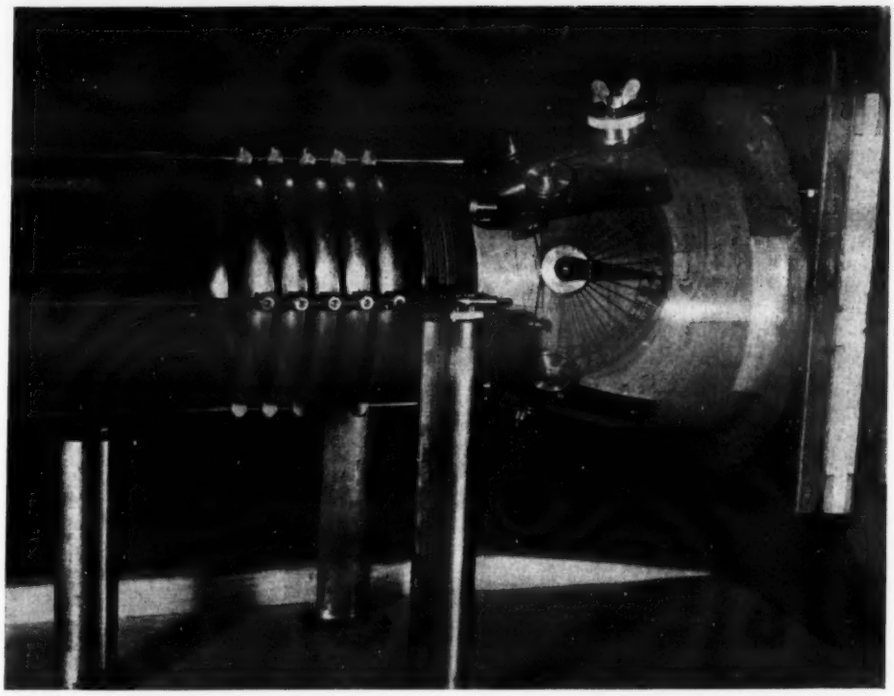


Fig. 6. — Jet pipe with deviator rings and internal vanes for imparting rotation to jet stream, together with equipment for measuring the forces acting on the deviators.

4. Minimum interference with jet in normal operation (jet efficiency !)

The first two requirements are self-evident. The third had to be specified in order to prevent surging of the engine when the thrust brake is in operation. The fourth takes into account the fact that the advantages of thrust braking should not be paid for by a substantial deterioration of the jet efficiency in normal operation.

A deviator which largely meets the four requirements was proposed by Professor Ackeret and studied by the writer. It works as follows :—

At the end of the jet pipe a number of half-torus-shaped deviator rings is arranged. A ring of controllable vanes imparts a rotational movement to the jet stream before it leaves the jet pipe. Under the effect of centrifugal force it spreads outwards upon leaving the pipe, gets caught by the deviator rings and is deflected.

When the vanes are set in the direction of the flow, thus not imparting any rotational movement to the gas stream, the jet emerges straight from the pipe and flows through the centre of the rings without being deviated. By moving the position of the vanes the change-over from normal flow to deviated flow and vice-versa can be effected in a minimum of time. The two positions are diagrammatically illustrated in Fig. 5. The deviating rings can be designed so as to retract over the jet pipe and would be extended only just before landing.

Tests so far carried out with this deviator have been conducted in the incompressible range. Fig. 6 shows the mounting of the deviating rings in the testing arrangement devised to measure the forces acting on them.

Fig. 7 is a sketch of the experimental arrangement designed to measure the braking and propulsive thrusts.

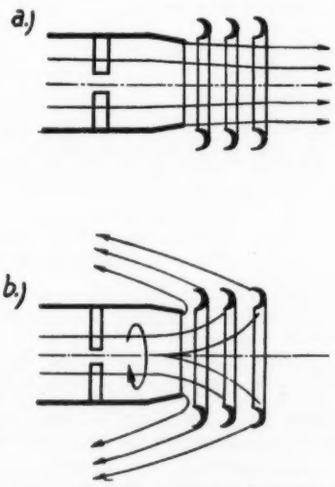


Fig. 5. — Diagram of investigated thrust brake :

(a) *Vanes in neutral positions : normal forward jet thrust.*

(b) *Vanes in rotated position : deviated jet.*

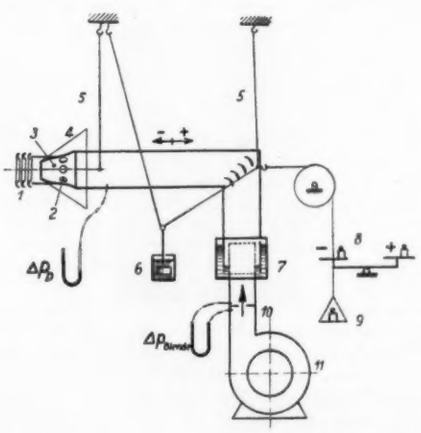


Fig. 7. —

1 Deviator rings
2 Vane control
3 Jet nozzle
4 Shielding
5 Suspension
6 Pre-loading weight and hydraulic damper
7 Water seal
8 Balance for thrust measuring
9 Dead weight
10 Diaphragm for flow measurement
11 Blower

Process of deviation

Rotation of the vanes from the neutral position (zero flow rotation) has the following results :—

When the vane is rotated from 0° (neutral) to about 45° while the air supply per second is kept constant, the forward thrust of the jet first diminishes only slightly, but then the thrust drops quickly, depending on the arrangement of the rings, to 50 % or even 20 % of the full thrust S_o (S_o = jet thrust with equal air supply at zero rotation with dismounted deviating rings). In this process, the pressure differential $\triangle p_D$ before the jet nozzle (compared with the outside pressure rises by 20%-30% of the value at zero flow rotation ($\triangle p_{Do}$). The force acting on the deviating rings increases, as the outside part of the flow is already partially caught by the rings. When the vanes are turned another 1-2°, the jet suddenly catches in the deviator rings and the pressure ahead of the nozzle increases another 30-50% (depending upon the ring arrangement). The thrust changes over from propulsive to breaking thrust (50 to 70% of S_o) and the force acting on the deviators grows suddenly. Further vane rotation will produce even higher brake thrusts, but $\triangle p_D$ will rise very steeply.

The unfavourable forward thrusts obtained with extended deviator rings and zero rotation [4] were improved to 90 % of S_o by increasing the inside diameter of the rings (Fig. 9 curve *b*). Somewhat greater " catching angles " (vane angle at moment of the deviated jet being caught up in the rings) and smaller brake thrusts (about 50% of S_o) resulted. Curve *a* in Fig. 9 reproduces, for comparison, the case with smaller ring inside diameter illustrated in Fig. 8.

Regarding Fig. 9 it should be observed that all jet nozzle pressure differentials ($\triangle p_D$) are reduced to the condition *without rings or cone* ; it is for this reason that differing numerical values resulted for the various arrangements in the neutral position ($\alpha = 0$).

A deviator of this kind would meet the requirements for relatively high braking thrusts, rapid changeover from braking to forward thrust and small effect on normal operating efficiency (the rings are retractable as stated, and with suitable airfoil sections the vanes will set up only very little drag in the jet flow). But the requirement for practically negligible repercussion on the engine was not fulfilled owing to the great increase in pressure ahead of the jet nozzle.

Full attention was therefore paid to the problem of eliminating this pressure increase, and several measures were tested.

[4] This thrust should not be mistaken for the normal thrust available in flight with retracted rings. It is the thrust immediately available in the first seconds after a baulked landing, before retraction of the rings.

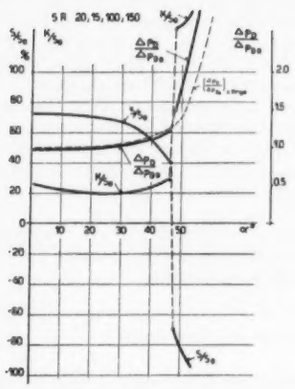


Fig. 8. — Thrust brake (incompressible).
Thrust, force acting on deviator rings and pressure differential in function of the vane angle.

a) Cone

By mounting a cone (diffusor) of wide opening angle to the jet nozzle it was intended to provide a practically automatic regulation of the jet nozzle pressure. At zero rotation the jet was to separate from the cone and rejoin it only gradually when spreading outward under the effect of increasing rotation, thus making effective the pressure recovery of the diffusor. It was also to be expected that guiding the jet towards the rings would facilitate its being caught, resulting in a lower rate of necessary rotation and correspondingly smaller pressure increase ahead of the nozzle.

Curve *C* in Fig. 9 illustrates the results thus achieved. The pressure recovery materialized ; a smaller " catching angle " resulted (42° instead of 48°). But the final pressure jump at the catching moment remained. Disagreeable was also the fact that the jet showed a tendency to hug one side of the cone at zero rotation, meaning its oblique emergence from the pipe. Accordingly, the positive thrusts were small. The braking thrusts, furthermore, dropped to 40% of S_o in all but one arrangement studied, and the exception provided 44 %.

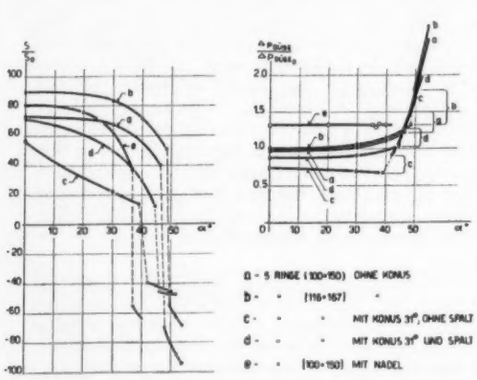


Fig. 9. — Thrust brake (incompressible).
Thrust and pressure differential ahead of nozzle in function of the vane angle for various types of arrangement tested.

b) Cone and slot

In order to prevent the jet from emerging obliquely, a slot was left between the nozzle and the cone. The jet now escaped normally. However, the diffusor effect of the cone fell off, although the arrangement still offered advantages over that without the cone in the form of a lower pressure increase ahead of the nozzle up to the moment of " catching " (15 % instead of 28 % of Δp_D). Even the pressure leap at the moment of catching was somewhat smaller in many cases. Positive thrust at zero rotation again reached higher values (72-80 % of S_o) and so did the braking thrusts (50-58 % of S_o). On the other hand the rate of rotation required for " catching " was higher again (46-48° vane angles).

Of decisive importance was the fact, however, that the pressure jump at the moment of " catching " remained (in the most favourable case 10.5% of the value before " catching " and 10.8 % of Δp_o). Hence it was attempted to keep the pressure ahead of the nozzle constant by regulating the nozzle cross-section.

c) Needle control

As in earlier German engines, an axially movable needle was used to modify the nozzle area.

Tests showed that for every vane angle α a needle position can be found which will maintain the nozzle pressure at a constant level. The elimination of the pressure jump at the moment of " catching " requires great precision in the co-ordination of vane angle control and needle movement, as the " catching " process occurs within a small angle range, whereas the pressure jump to be offset amounts to more than half of the total pressure increase.

It was found, however, that it was sufficient to adjust the vanes to an angle just short of that required for " catching " and that the " catching " process itself could be provoked by moving the needle alone (keeping the vane angle constant). It was found to be necessary to *withdraw* the needle in order to induce the jet stream to catch in the deviator rings ; and this simultaneously regulates the pressure in the desired direction.

Curve *e* of Fig. 9 shows the values measured with the arrangement. The pressure ahead of the nozzle remains constant until the moment of "catching", fluctuates about 4 % from the mean value during the process (from —1.7 to + 2.3 %) and can then be regulated completely. Positive thrust was measured at 80.8% and braking thrust at 55.2% of S_o, at a "catching " angle of 37°. (Here it should be noted that owing to the mounting of the needle, the vanes had to be shaped differently from those used previously and that the relation between the angle of flow rotation and vane angle is different.)

An arrangement had thus been found which satisfied all four requirements that had been formulated. Since many modern engines feature variable area nozzles for afterburning purposes, their clamshell or flap-type controls can be employed in conjunction with thrust braking.

Concluding remarks

All tests have so far been conducted with an incompressible cold air jet on a static bench (i.e. without relative wind). The effects of compressibility on the spreading outward of the jet stream under the effect of rotation will be investigated. As regards the relative wind of the rolling aircraft, this is expected to increase only slightly the difficulty in making the jet " catch " in the deviators, since the momentum of the jet is great in comparison with the relative wind ; it should be possible to offset its effect by slightly increasing the rotation of the jet stream.

Altogether 140 arrangements were measured in order to determine the optimum location and attitude of the deviator rings and effect of the number of rings on thrust deviation. It was found that 2 or 3 rings may be sufficient. Three-ring deviators have a performance barely lower than that of 5 rings and on the whole provide better forward thrust for emergency after baulked landings. They require a little more rotation of the jet stream.

It may be mentioned that it is possible partly to cover the rings in order to create gaps in the deviated jet at points where it would hit wings or tail surfaces.

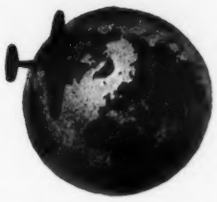
*

These experiments were designed to determine the feasibility of a thrust brake design based on the principle proposed by Professor Ackeret. In view of the favourable results obtained, experiments in the compressible range have now been prepared and are due to begin shortly. They should provide detailed basic data for experiments with actual turbojets.

AIR ALGÉRIE

Several errors have slipped into the paragraph devoted to *Air Algérie* (Compagnie Algérienne d'Aviation) as part of the article published in *Interavia Review* No. 1, 1953, on " I.A.T.A's New Members." The points listed below will correct any mistaken impressions created by these inaccuracies :—

1. At no time since the company's foundation has Air France held a share of its capital.
2. The company's capitalization was increased from Fr. frs. 28,000,000 to Fr. frs. 140,000,000 in December 1948 through the distribution of bonus shares and subsequently to Fr. frs. 168,000,000 through the subscription of stock by the company's founder-shareholders.
3. Since its creation in December 1948, the Board of Directors of Air Algérie has held 98 % of the company's capital, and this is still the case today.
4. On 15th June 1952, the shipping groups of *Fraissinet* and *Cyprien Fabre* joined the Board of Directors upon acquiring 51 % of the capital.
5. Finally, Air Algérie's air fleet at the present time consists of five Douglas DC-3's, six SO 30 " Bretagnes " and one Bréguet 761, making a total of 12 aircraft.



What's in the Air ? *

Aviation politics

● *British jet fighters for the Middle East.*—Early in February the House of Commons debated the vexed question of the *export of British jet fighters to Middle East countries.* The Labour Opposition asked that deliveries be delayed until " a settlement has been reached between Israel and the Arab States."—On the other hand Minister of State Selwyn Lloyd stated that these exports, based on orders from Middle Eastern States placed and partially paid for in some cases several years ago, were governed by the joint declaration by Britain, the United States and France on May 25th, 1950, which recognized the *need of Middle East States to maintain certain armed forces.* (The Arab States have ordered a total of 60 jet fighters, and Israel twelve.)

● *French plans for 1953.*—Towards the end of January, *French Air Minister Pierre Montel* told the press that the *French aviation programme for 1953 was by no means of a revolutionary nature.* Air forces would not be increased, but the industry must be held above water and the closing of aircraft factories avoided. The Minister stressed that a *rearmament plan can only be carried out in conjunction with a carefully prepared finance plan.*

● *Japanese defence budget.*—The Japanese budget proposals for 1953/54 contain an item of 2,300,000,000 yen for the purchase of 100 training, liaison and reconnaissance aircraft and 24 helicopters, to be shared between the *National Security Corps* (Hoantai) and the *Coastal Security Corps* (Keibitai).—Flying training courses by the Security Corps began on January 12th, 1953 at Hamamatsu base, near Mikatagahara, with a first class of 60 students (without exception former Air Force officers with at least 2000 flying hours to their credit).

● *Background to Formosa.*—The U.S Air Force began *training of Chinese Nationalist jet fighter pilots* at Williams Air Force Base, near Phoenix (Arizona) late in January 1953. This may indicate that the Pentagon plans to equip Chiang Kai-shek's Chinese Nationalist forces with jet fighters.

Service aviation

● *Medium versus heavy bomber ?* According to American press reports, a total of *400 Boeing B-47 " Stratojet " bombers* has now been built in the United States, and the annual production rate has reached 500. The first B-47s have already arrived at March Air Force Base, near Riverside, California, to replace the B-29 " Superfortresses " now in service with the U.S Air Force's 22nd Bombardment Group. The 320th Group is also to be converted to " Stratojets " during the spring. The relatively high production figures might indicate that the U.S. Air Force now prefers the fast " medium " bomber to the " intercontinental long-range bomber ".

● *Sweden's guided missiles programme.*—The *Swedish Navy's six-year plan* earmarks particularly *high sums for the development of guided missiles.* Details of the final programme are not yet available, but the original credit of 63,600,000 Kronor will probably be granted in full. This sum does not include expenditure on research institutes. The Army and Air Force are also said to have guided missiles programmes.

● *" Canberra " record flight.*—On January 27th-28th, 1953, a Royal Air Force English Electric " Canberra " jet bomber, captained by Flight Lieutenant Leslie M. Whittington, covered the 8,608 miles between *London Airport and Darwin in 22 hours 00 mins. 21.8 secs.* Pure flying time (not yet confirmed) is said to have been 19 hours 1 min. 22.8 secs. The previous record (45 hours 35 mins.) was set up by an Avro " Lancaster " bomber in 1946.

● *Eastern bloc rearmament.*—According to the American magazine " Fortune " *Russia has produced 40,000 aircraft since the end of the war* and now has 20,000 first-line models (compared with 10,000 in the U.S.A.) and 20,000 reserve aircraft. The number of Russian long-range bombers is said to be about 1000, which equals the U.S. Air Force Strategic Bomber Command's fleet. Annual production is estimated at 10,000 aircraft.—The four Eastern bloc countries, *Hungary, Rumania, Bulgaria and Albania,* have almost trebled the peacetime strength of their forces since 1948, bringing them up to 60 Army divisions and 12 Air Force divisions at the beginning of 1953. There are said to be over 200 air bases on the territory of these four countries, including 20 which are suitable for rocket aircraft.—The *East German Air Force* now being built up has just formed its first *Air Force Corps* with squadrons stationed at Kottbus, Kamenz and Bautzen and equipped provisionally with Russian piston-engined trainers.

On February 25th, 1953 Wolfgang von Gronau *celebrated his 60th birthday. One of Germany's best known pilots before the war (for example he made the Germany-Greenland-New York flight in a Dornier Wal in 1930), for many years president of the Aero Club of Germany, vice-president of the FAI, he was recalled to the Luftwaffe in 1939 and sent to Tokyo as Air Attaché, where he remained until the end of the war. Von Gronau, who has recently been engaged in private business, enjoys considerable respect both inside and outside Germany, and might perhaps be called upon to play an active part again in German civil aviation.*

Air transportation

● *Helicopter for discussion by IATA.*—The *Technical Conference of the International Air Transport Association* to be held in San Juan (Puerto Rico) from April 20th to May 2nd, 1953, is to feature for the first time a discussion of the *uses of the helicopter in regular air traffic.* Altogether 200 experts in the building, operation and maintenance of helicopters and representatives of international organizations and research institutes will attend the conference, at which an attempt will be made to reconcile the development plans of the makers with the desires of air transport carriers. The agenda includes design, economics, specifications and traffic regulations for helicopters.—As the ordinary members of IATA earn their living by international services, this conference shows that helicopters are expected ultimately to operate beyond national frontiers.

● *PAA's New York-Puerto Rico services.*—Growth of traffic volume on PAA's New York-San Juan (Puerto Rico) service, which was inaugurated on July 1st, 1946 is shown by the following figures : on February 2nd, 1953 the company flew its 25,000th regular service on the route. Whereas initially there were only 14 flights a week, this figure has increased gradually to no less than 80. In 1952 a total of 214,489 passengers was carried, compared with 87,645 during the first full operating year (1947).

● *India's nationalization plans.* — A bill recently presented to the Indian Parliament and expected by Indian aviation circles to become law in April 1953, calls for the *nationalization of the whole of Indian air transport.* A new *Government airline,* the Air Transport Corporation, would take over all the operations (domestic and international) of nine private companies. The total compensation proposed is $20,000,000. It is reported that the Indian Government is planning to make *J. R. D. Tata,* Managing Director of the giant Tata concern, *first Chairman of the new corporation.* Tata is major shareholder in the two principal airlines operating domestic and international services, Air-India and Air-India International.

● *... And a Japanese monopoly company ?* According to an official report from Tokyo the Japanese Ministry of Transport is considering the establishment of a " *chosen instrument* " *for Japanese overseas traffic,* i.e. a *Government-controlled monopoly company.* This will probably be *Japan Air Lines Co.*—Towards the end of January 1953 this company obtained monopoly in domestic traffic by absorbing Nihon Helicopter Yuso, Kyokuto Koku and Tokyo Koku airlines.

* Extracts from " Interavia Air Letter ", international daily news digest, in English, French and German. All rights reserved.

Industrial

● *The American jetliner position.*—The *question of cost* appears to be becoming the *central problem connected with the American jetliner.* The " Air Letter's " correspondent on the West Coast of the United States reports that in his opinion orders for jetliners will continue to be small if the manufacturers stick to their prices of $4,000,000 to $5,000,000 for their designs. —However *Eastern Air Lines President Captain Eddie V. Rickenbacker* is planning a tour of the West Coast factories to try and persuade them to reduce the price of their projected jet airliners.—Meanwhile *Donald W. Douglas, Managing Director of Douglas Aircraft Corp.*, has spoken *very confidently on his company's development work* to the Los Angeles Chamber of Commerce : " when the time is ripe " 60-seat American jetliners will cross the continent in four hours and will " make money as well as headlines ".

Martin P5M-1 " Marlin " patrol flying boat.

● *Convair's oil interests.*—Consolidated Vultee Aircraft Corp. has insured itself against a falling-off in the armament boom by the purchase of oil interests in six American countries. The shares of the *recently-founded oil prospecting subsidiary, San Diego Corp.*, have been issued to Convair's stockholders in the form of a dividend (one oil share per ten Convair shares).

● *British guided missiles.*—Minister of Supply Duncan Sandys asked the House of Commons in January for an extra £16,000,000 for development of guided missiles, in addition to the £128,000,000 already granted. The Minister stressed the considerable progress made in British research and development during recent years and stated that *guided missiles would form a decisive contribution to British armament in the very near future.*—Two leading industrial concerns appear to be interested in *creating guided missile test centres in Australia: English Electric Co.* and *de Havilland.*

Flying equipment

● Work has begun on the prototype of the *de Havilland " Comet 3 "* four-jet airliner. The " Comet 3 " will have larger wing and landing flap areas than earlier marks. As is known, it will be able to carry 78 passengers for a payload of 20,200 lbs (9160 kg), or 58 passengers for a payload of 17,450 lbs (7915 kg). In the latter case, range (including reserves and 50-m.p.h. head wind) will be 2,700 miles (4350 km).

● Early in January the *SO 1220 " Djinn "*, the SNCA du Sud-Ouest's single-seater experimental helicopter with jet power, began flight testing. The aircraft (gross weight 550 lbs) is fitted with a Turboméca " Palouste " gas turbine.

● The *Hurel-Dubois HD 31* twin-engined freighter also began flight testing at Villacoublay on January 27th. Maurice Hurel, the firm's managing director and designer of the HD 31, took part in the first flight.

● *SNCA du Nord* has come to an agreement with Société MATRA and the designer Cantinieau for the joint development of a twin-engined helicopter for a pilot and 4 passengers. The helicopter, fitted with two SNECMA 4 L O engines of 270 cv, will probably be a development of the MATRA-Cantinieau MC 101 type already described in these pages.

● The glider model of a delta-wing aircraft, known as Type 1301, made its first flight at Istres in mid-January. The machine, designed by SFECMAS (Société Française d'Etude et de Construction de Matériels Aéronautiques Spéciaux, successor to Arsenal de l'Aéronautique), is probably a model of a projected delta-wing high-performance aircraft.

● The *Macchi M.B. 323* two-seater all-metal low-wing monoplane trainer (600 h.p. Pratt & Whitney R-1340 " Wasp ") is now to be offered for export.

● The *Ambrosini " Sagittario "* 45° swept-wing aircraft (Turboméca " Marboré " turbojet) has started flight testing at Aviano airfield.

● Engineer Giovanni Casiraghi of *Piaggio & C.*, Genoa, has been working on the projects of two aircraft types, both to be offered on the world market. The first is a *twin-engined medium-range airliner*, which will compete in equipment and performance with the American Convair 340 and Martin 4-0-4 models. The second is a *four-seat sports and touring aircraft*, about which nothing further is known.

● The *Convair XF2Y-1 " Sea Dart "* supersonic delta-wing seaplane fitted with " hydroskis " has made its first test flights.

● *Glenn L. Martin* is working on a jet-powered fighter seaplane.

● *Fairchild C-119G* is the latest version of the C-119 twin-engined transport. Like the " F " and " H " versions, the C-119G has 3500 h.p. Wright R-3350-85 compound engines. Span 109 ft. ; length 86 ft. ; gross weight 74,400 lbs ; payload 29,400 lbs. ; accommodation for 67 men.

● The following data, not yet confirmed by the makers, of the *Saab-32 " Lansen "* ground attack aircraft of Svenska Aeroplan AB have been reported : span 42 ft. 7¾ in. ; length 49 ft. 2½ in. ; height about 16 ft. 5 in. ; wing sweep approx 35° ; gross weight about 10 tons ; maximum speed about 680 m.p.h. ; normal range over 1240 miles.

Power plant

● According to latest reports, the *General Electric J-73-GE-1* turbojet with axial compressor delivers a static take-off thust of 8500 lbs. Earlier unofficial statements gave static thrust with water injection and reheat as 10,000 to 12,000 lbs.

● *D. Napier & Son Ltd.* is said to be working on a development of the " Nomad " compound engine. Power of the " Nomad II " is not known ; the earlier model of the " Nomad " delivers 3000 shp plus 320 lbs residual thrust.

● A process for *braking jet aircraft during landing by reversing thrust* has been patented in the United States by a Swedish inventor, Oskar Lundberg. The jet pipe outlet is completely closed and the exhaust gases escape through channels in the walls in the opposite direction to that of flight.—As is already known, a braking process through thrust deviation has been developed in France by SNECMA and has undergone successful practical tests. (See elsewhere in this issue an article on the subject from the Aerodynamics Institute of the Federal Institute of Technology, Zurich.)

It is with great regret that we have to announce the death on February 7th, 1953, of

André de RHAM

at the age of 37, after a long illness.

Mr. de Rham had been a member of our editorial staff since 1947 and was responsible in particular for the technical side of our French editions. An experienced engineer and sound technical writer, a man of outstanding integrity, he was a loyal colleague and valued friend. He is sorely missed by all his colleagues.

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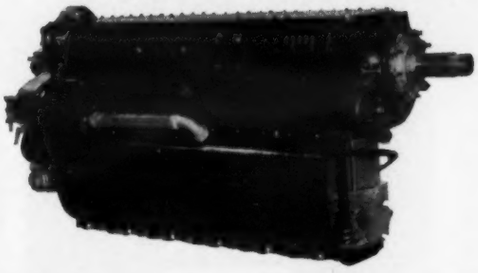

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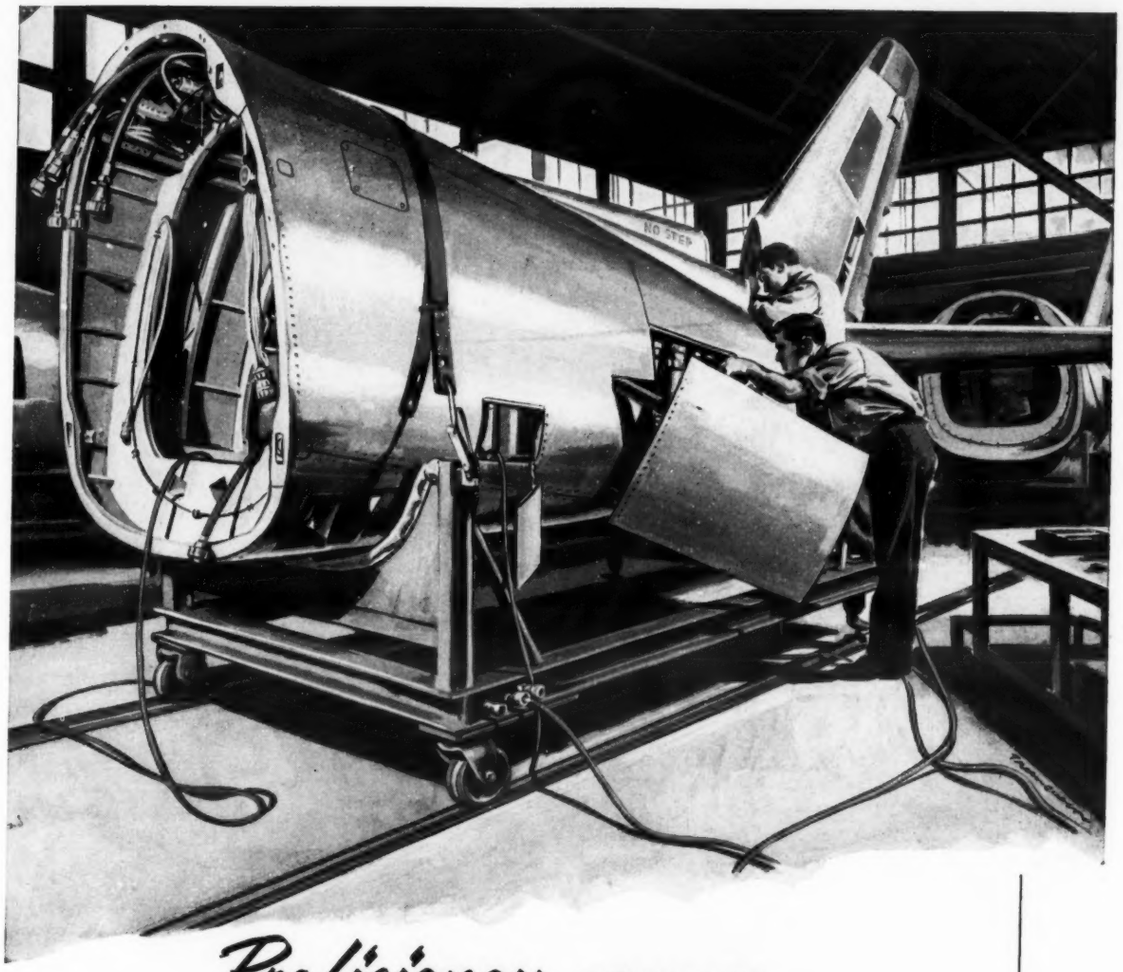

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